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USSR Report

ENGINEERING AND EQUIPMENT



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UDC 681.325+681.326

AUTOMATED MULTIDIMENSIONAL ANALYZER BASED ON SM-3 KAMAK

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 5, Sep-Oct 85
(manuscript received 24 Feb 84) pp 67-7.

KUPCHAK, R., SOLTAN, A., SKOBELEV, N.K., LEVITOVICH, M., YANKOVSKI, A. and
BALUKA, G., Consolidated Nuclear Research Institute

[Abstract] A multichannel multidimensional analyzer based on an SM-3 computer with KAMAK access is described. A general-purpose 16-bit SM-3 computer with 32K access memory controls the system. The KAMAK standard equipment connection method makes it possible to input $8n$ parameters (where $n = 1, 2, \dots, 20$). Fully automated experimentation is supported by the design of the electronic equipment and software. The operating algorithm of the system is flow-charted and explained. The system can record up to 1,000 events per second, and is reliable and easy to operate. The use of the system to gather information from sensors in the focal plane of a magnetic analyzer, and to measure the flight time of recorded reaction products, is described. Figures 4; references: 9 Russian.
[6900/52]

UDC 53.082.1.004.13:629.785

SCANNING DEVICE EMPLOYING CONTACTLESS MAGNETOELECTRIC DRIVE AND OPTOELECTRONIC ANGLE READOUT FOR SPACECRAFT INSTRUMENTS

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 2, Mar-Apr 85 (manuscript received 29 Apr 84) pp 203-206

VAKULOV, P.V., GORDEYEV, Yu.P., MELNIKOV, V.V., SAVIN, B.I., SHIRYAYEVA, V.Ya. and YAKOVLEV, B.M., Scientific Research Institute for Nuclear Physics, Moscow State University

[Abstract] A device for rotating a detector in open space is described that has been developed for the scanning electrostatic analyzer carried aboard the Interkosmos-18 satellite. The device incorporates a moving head that holds

the detector, a magnetoelectric drive consisting of a permanent magnet and stationary coils that are coupled to the head, a slotted code disc that fits in a yoke that employs six pairs of light-emitting diodes and photodiodes, an electronic angle-of-revolution display circuit, and a drive control. Negative feedback is employed to stabilize and limit the amplitude. The system consumes less than 10 mW. While in operation aboard Interkosmos-18, the period of the device remained constant to within $\pm 0.4\%$; within 20 days of continuous operation this figure dropped to 18%. The amplitude of the oscillations increased by several degrees over 20 days, apparently due to gradual reduction of the friction in the bearings. Figures 2, reference: 1 Russian. [326-6900]

SURFACE TRANSPORTATION

UDC 531.8

GAIT CONTROL OF FOUR-LEGGED WALKING APPARATUS DURING TROT, CANTER AND GALLOP

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian No 5, Sep-Oct 85 (manuscript received 11 Apr 85) pp 39-45

LAPSHIN, V.V., Moscow

[Abstract] The gait of a four-legged walking apparatus on a flat surface is analyzed, for purposes of control during trot (diagonal pairs of legs alternately in support phase), canter (left pair and right pair alternately in support phase), and gallop (front pair and rear pair alternately in support phase), with a support phase followed by a flight phase in each case and a sequence of two such phases constituting a step. The gait is programmed for linear uniform motion, in horizontal projection, of the center of mass of the body with all four legs assumed to be weightless, with a zero yaw angle in each case and with also zero roll angle during canter and gallop. The algorithm of gait stabilization, including also control of the pitch angle, is constructed on the basis of corresponding equations of periodic motion and solution to the corresponding problem of quadratic programming for optimum control. A special case is dynamic pacing, with zero flight time. Calculations have been programmed for simulation on a digital computer. References 4: all Russian.

[36-2415]

UDC 531.8

WALKING, SKIPPING AND RUNNING OF TWO-LEGGED WALKING APPARATUS WITH CONSIDERATION OF IMPACT

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian No 5, Sep-Oct 85 (manuscript received 23 May 84) pp 46-51

RUTKOVSKIY, S.V., Moscow

[Abstract] Three modes of walking are considered for an antropomorphic apparatus, with impact against the ground taken into account. The

differential equations of motion for walking, skipping, and running are in each case put in the Lagrange form, with the vector of generalized coordinates (q) defining posture and the vector of generalized coordinates and velocities (q, \dot{q}) defining the phase state. Solution of these systems of equations yields the expended energy as function of the mean velocity. Each mode of walking, assumed to be a periodic motion, has been simulated on a BESM-6 high-speed computer for numerical evaluation of comfort-discomfort ranges. The author thanks V.V. Beletskiy for interest. Figures 4; references 11: all Russian.
[36-2415]

UDC 62.88.6

NOVEL CONFIGURATION OF DIFFERENTIAL DRIVE

Moscow IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 4, Apr 85 (manuscript received 30 Oct 84) pp 112-116

SUDAKOV, N.V., candidate of technical sciences, docent, VYDRIN, V.N., doctor of technical sciences, professor, and GUSTOV, V.A., engineer

[Abstract] A novel configuration of a differential drive with active shaft and reactive shaft is shown where the installed power can be reduced to the load level regardless of the speed ratio, without the complexity of a conventional differential speed reducer and without the inflexibility of a tandem drive. Its two shafts are driven by separate motors, the active one by the main motor and the reactive one by the auxiliary motor. The rotor of the main motor is coupled to the reactive shaft, while its stator-inductor resting on supports is kinematically coupled to the gear transmission as well as to the active shaft and the rotor of the auxiliary motor. An analysis on the basis of speed relations and torque relations confirms that the same load power, with given output speeds and torques, is attainable at various positive or negative transmission ratios as well as for the two shafts rotating with equal or different circumferential velocities over wide ranges of speed and torque ratios. The input power will be divided between main motor and auxiliary motor according to the ratio of torques at the two shafts. Figures 3; references: 4 Russian.
[271-2415]

MAXIMUM ATTAINABLE SPEEDS OF SMALL VEHICLES ON WHEELS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 4, Apr 85 (manuscript received 14 Aug 84) pp 76-79

NARBUT, A.N., doctor of technical sciences, professor, and MEDOVSHCHIKOV, Yu.V., graduate engineer

[Abstract] The maximum attainable speed and corresponding power requirement are estimated for three categories of small vehicles on wheels, on the basis of a semiempirical relation which accounts for weight distribution as well as air resistance and rolling friction, also adhesion between wheels and road surface. Numerical data are given for two bicycles weighing 70 kg and 90 kg respectively, two one-seater motorcycles weighing 90 kg and 130 kg respectively, one two-seater motorcycle weighing 200 kg, and three two-seater minicars weighing 200 kg, 300 kg, 400 kg respectively. The six lighter vehicles have rear-wheel drives and the two heavier minicars have front-wheel drives, all assumed to be moving on asphalt pavement. The data indicate that motorcycles and minicars offer economical transportation within city limits at speeds not exceeding 60 km/h and outside city limits at speeds not exceeding 90 km/h. Figures 2; tables 1; references 7: 6 Russian, 1 Western.
[271-2415]

UDC 629.114.2.032.1

METHOD OF IMPROVING PERFORMANCE OF TENSION MECHANISM ON CATERPILLAR TRUCK

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 4, Apr 85 (manuscript received 14 Aug 84) pp 79-84

VODCHENKO, O.P., engineer

[Abstract] The performance of a four-link mechanism for automatic tension control in a caterpillar drive is analyzed by the method of force and displacement diagrams, on the basis of geometrical relations and kinematics. The mechanism includes a rod which measures the tension on the outermost supporting roller and actuates the tension wheel accordingly. The results indicate that making the displacement of this rod follow the rotation of the resultant force vector reduces the error of tension measurement and consequently improves the stability of caterpillar tension through more accurate control as well as a more uniform pressure distribution over supporting rollers, which will reduce shaking of the truck body during motion over bumps or holes. Figures 3; references: 4 Russian.
[271-2415]

UDC: 621.181.142:621.039.524.2.034.36

STEAM GENERATOR FOR NUCLEAR POWER PLANT WITH VGR-50 REACTOR

Moscow ENERGOMASHINOSTROYENIYE in Russian No 3, Mar 85, pp 21-25

GLEBOV, V.P., Doctor of Technical Sciences, SIMKIN, B.P., Engineer, MOSKVICHEV, V.F. and GREBENNIKOV, V.N., Candidates of Technical Sciences, and OGURECHNIKOVA, G.V., ARTEMOV, L.N., and RYBAKOV, V.P., Engineers.

[Abstract] High-temperature helium-cooled reactors are promising for such industries as ferrous metallurgy and chemistry. Scientific research and development work is under way in the Soviet Union on gas-cooled thermal and fast neutron reactors. One such is the VGR-50 reactor, described in a previous work. This article describes a steam generator intended for use in nuclear power plants using the VGR-50 reactor. The generator is designed so that its load-bearing body does not contact the 800°C hot helium leaving the reactor, but rather is washed only by helium after its temperature has dropped to 280°C, having given up heat in the secondary loop. The hot helium does touch the pipes of the heating surface and internals protected by insulation and receiving force only due to the pressure drop in the gas line. Four steam generators with a total thermal capacity of 137 MW are used with the VGR-50. The planning and scientific research work performed indicate the possibility of creating a reliable steam generator in a metal body for nuclear power plants using the VGR-50 reactor. Figures 4, references 5: 4 Russian, 1 Western.

[294-6508]

STUDIES OF HEAT AND HYDRAULIC CHARACTERISTICS WITH EXTERNAL FLOW AROUND HEATING SURFACES OF NUCLEAR POWER PLANT STEAM GENERATORS WITH GAS-COOLED REACTORS

Moscow ENERGOMASHINOSTROYENIYE in Russian No 3, Mar 85 pp 25-29

BURKOV, V.K., YUDIN, V.F. and FEDOROVICH, Ye.D., Candidates of Technical Sciences, and SVIRIDOVA, N.M., Engineer.

[Abstract] Studies of the heat output and resistance of corridor bundles of straight pipes washed transversely by coolant were performed on a test stand consisting of seven modules, each of which consists of two series-connected coils. The experiments measured water inlet and outlet temperature, air temperature at the intake and at seventeen points along the cross-section, and also at the outlet, water and air flow rates and the air velocity field at the outlet. An equation is suggested for calculation of heat transfer when coil modules are washed by a coolant, satisfactorily describing the experimental data. Both heat transfer and resistance increase with an increase in the relative longitudinal step of the coils. Older equations designed for bundles of straight corridor tubes are not accurate. Figures 5. [294-6508]

UDC: 533.6.001.5:621.039.534.25.36

STUDY OF AERODYNAMICS OF INTAKE AND OUTPUT GAS CHAMBERS OF STEAM GENERATOR INSTALLATION USED WITH VGR-50 REACTOR

Moscow ENERGOMASHINOSTROYENIYE in Russian No 3, Mar 85 pp 29-32

PIKUS, V.Yu. and SHRADER, I.L., Candidates of Technical Sciences, and SIMKIN, B.P., Engineer.

[Abstract] A study was performed of the chambers in a steam generator installation for use with a VGR-50 nuclear reactor on a hydraulic modeling test stand, utilizing a visual study of the movement of the medium in the model by means of tracers, combined with measurements of the distribution of flow of the medium and the pressure drop through the model. The model reproduces the geometry of the input and output chambers on a scale of 1:3.4. An experimental analysis of the flow picture at the output from the tube bundle was performed on the basis of results of measuring pressure drop across the output elements of the module. Two output element mock-ups were studied with a hydraulic resistance somewhat less than that of the actual element. It was found that with either mock-up the distribution of flow through the cross-section of the tube bundle changes linearly with radius, with greater flow toward the center of the segment. The maximum speed nonuniformity increases from about 15 to about 30% with a decrease in output element resistance. Figures 4, references 5 Russian. [294-6508]

TEST STAND STUDIES OF SYSTEM FOR REMOVING GRAPHITE POWDER FROM STEAM GENERATING INSTALLATION USED WITH VGR-50 REACTOR

Moscow ENERGOMASHINOSTROYENIYE in Russian No 3, Mar 85 pp 32-35

LARIONOV, V.V., Candidate of Technical Sciences, DANCHENKOV, Yu.V. and LYUTERSHTEYN, A.M., Engineers.

[Abstract] Experimental studies were performed on a model steam generator to estimate the possible deposition of graphite and work out methods for removing the deposits. The studies were performed in two stages; in the first stage the process of formation of deposits in the steam generator was studied in order to develop specific recommendations for improvement of its gas dynamic characteristics to decrease the intensity of the formation of deposits. In the second stage the system for removal of graphite dust deposited on the interior surfaces of steam generator elements was studied. Analysis showed that the most probable locations for deposits are the inclined diaphragm separating the intake and delivery sides of the gas blower, the cover of the heat exchanger shell and the bottom of the steam generator. These elements were included in the model. During the course of the tests, the dust which collected on the separator diaphragm, upper cover and at the bottom of the steam generator was collected and weighed, and then the particle size distribution was determined. It was found that a very small portion of the graphite dust was precipitated on the diaphragm and upper cover, but removal of dust from these elements by pulsed cleaning complicates the design of the steam generator. It is better to increase the slope angle of the diaphragm to 40-45° and make the cover with an aperture angle of 100°, based on studies of the angle of natural repose of graphite, in order to exclude the possibility of formation of dust deposits and reduce radiation danger during repair of the equipment. Figures 4, references 4 Russian.

[294-6508]

UDC: 621.311.25:621.039:621.181.61

TEMPERATURE CONDITIONS IN AREA OF POOR HEAT EXCHANGE IN NUCLEAR POWER PLANT STEAM GENERATORS

Moscow ENERGOMASHINOSTROYENIYE in Russian No 3, Mar 85 pp 35-38

KUDRYAVTSEV, I.S., PASKAR, B.L. and SUDAKOV, A.V., Candidates of Technical Sciences.

[Abstract] The most reliable data on temperature surges in nuclear power plant steam generators can be obtained experimentally using models with similar geometry. The physical conditions in the areas being tested must be identical in the model experiments to the actual steam generator. This requirement of identity is analyzed in some detail, as are a few other aspects

of performing experiments to determine temperature conditions, using as an example the area of poor heat transfer (second-order crisis) of direct-flow steam generators. The need is demonstrated for attachment of thermocouples directly on internals rather than on the external body outside the devices. Results are presented from a study of the temperature conditions of a helical coil steam generator channel for installations with high-temperature reactors cooled by sodium and helium. Experiments were performed with a heat flux density of 350 to 900 kW/m², mass velocity 350 - 2000 kg/(m²s), and pressure 15 MPa. The results of the experiments show that heat exchange crisis in this case is local in nature. As the mass content of steam increases, the temperature of the internal generatrix becomes significantly higher than the saturation temperature, while temperature surges decrease. Figures 5, references 5 Russian.

[294-6508]

HEAT TREATMENT OF WELDED JOINTS IN PRIMARY CIRCUIT PIPE WITH V-1000 REACTOR AT NUCLEAR POWER PLANT

Moscow ENERGOMASHINOSTROYENIYE in Russian No 3, Mar 85 pp 19-20

DYMCHENKO, V.V., Candidate of Technical Sciences, JHUL'MAN, I.A., Engineer.

[Abstract] The primary loop pipe welded joints used in the VVER-1000 reactor are heated and subsequently heat treated. The thermal deformation arising in the heating zone near the reactor body causes residual stresses. A technology has been developed for heat treatment of welded joints by means of an induction installation operating at 1000 Hz. The level of residual stresses achieved was determined. Heat treatment was found to ensure a minimal level and uniform distribution of residual stresses around the seam (40 to 80 MPa) and in the wall of the body, with satisfactory mechanical properties. Tempering under the control of an automatic programmer is suggested.

[294-6508]

UDC 621.039.577

EFFECT OF NONUNIFORM HEAT RELEASE IN POWER REACTORS ON THEIR POWER UTILIZATION FACTOR

Ashkhabad IZVESTIYA AKADEMII NAUK TURKMENSKOY SSR: SERIYA FIZIKO-TEKHNICHESKIKH, KHIMICHESKIKH I GEOLOGICHESKIKH NAUK in Russian No 1, Jan-Feb 85 (manuscript received 24 Feb 82) pp 29-34

BAUM, V.A. [deceased] and BEKMURADOV, O., Turkmen State University imeni A.M. Gorkiy

[Abstract] The performance of a water-moderated, water-cooled power reactor is analyzed, specifically the effect of a nonuniform temperature field and

thus nonuniform heat release on the power utilization factor characterizing the thermal output per unit volume of the reactor core. This factor, which is equal to the ratio of heat extracted in a real reactor with discrete assemblies of fuel elements to heat which can be extracted in an ideal reactor with uniform distribution of coolant temperature over the core cross-section, is accordingly calculated first for an ideal continuous distribution of heat sources and then for fuel element assemblies spaced discretely around the core circumference. Heat generation within the reactor core is assumed to have a sinusoidal profile over the core height, and heat conduction in the direction of coolant flow is assumed to be negligible in comparison with heat convection; the thermal conductivity of the fuel rods is much smaller than the eddy thermal conductivity and constant thermophysical properties of the coolant are assumed. The corresponding equations of heat balance are solved in each case, taking into account geometrical symmetry with respect to the core axis so as to reduce the second problem to a two-dimensional one as well. Numerical results for a VVER reactor with the coolant outlet temperature not exceeding 275°C indicate that the power utilization factor η as function of the coolant parameter $\varepsilon = \lambda_T / (\rho c_p w)$ (ρ - density, c_p - specific heat, w - velocity, λ_T - eddy thermal conductivity) remains low and constant when ε is small ($\eta \approx 0.85$ over the $\varepsilon = 0-10^{-5}$ range in an ideal reactor, $\eta \approx 0.2$ over the $\varepsilon = 0-10^{-3}$ range in a real reactor) and then asymptotically approaches unity as $\varepsilon \rightarrow 10$ after a transition range of sharp increase. The difference in its trends depending on the dimensions of the reactor or its fuel element assembly configuration can be interpreted in terms of the parameter ε as the mean-free-path length of turbulent coolant particles and on the basis of the dependence of the temperature equalization process on that length. Figures 1; tables 1; references: 3 Russian. [248-2415]

DEVICE FOR CONTACTLESS MEASUREMENT OF REACTIVE POWER FACTOR

Ashkhabad IZVESTIYA AKADEMII NAUK TURKMENSKOY SSR: FIZIKO-TEKHNICHESKIKH, KHIMICHESKIKH I GEOLOGICHESKIKH NAUK in Russian No 1, Jan-Feb 85
(manuscript received 10 Jul 82) pp 87-90

NAZAROV, P.A. and NURYEV, B.S., Turkmen Polytechnic Institute

[Abstract] A device has been developed for contactless measurement of the reactive power factor, using a Ts-91 transformer yoke with window for a line (phase) conductor. It consists of a current-to-voltage converter, a stabilizer of the converter output signal, a stabilizer of the line voltage signal, and a comparator. The differences between the two stabilized signals, characterizing line current and voltage respectively, are graduated in the reactive power factor $\tan \phi$. Three stabilitrons 1,2,3, each consisting of a parallel-opposing pair, are connected at one end to the common ground with the transformer secondary, and at the other to the other end of the transformer secondary as follows: stabilitron 1 directly, stabilitron 2 through a resistor, and stabilitron 3 through a movement indicator and that resistor in series. A current-limiting resistor is inserted between the transformer

primary (line or phase conductor) and stabilatron 3 behind the movement indicator. The device operates on the basis of the voltage phasor diagram and over wide ranges of line (phase) currents, typically 15-800 A. The measurement error depends on the reactive power factor and on the stabilization error

$K = \Delta V/V_u$, namely $\delta = \sqrt{1 + \frac{K^2}{4 \sin^2 \varphi}} + K - 1$; the minimum error is equal to

half the stabilization error. Accordingly, the measurement error is much larger in the low current range such as 10-20 A. It can be minimized by ensuring that the internal reactance of the instrument is much higher than the sum of the internal resistance and stabilatron resistance. Figures 2; references: 2 Russian.
[248-2415]

UDC 620.1:621.311:621.039

BROADENED SCOPE OF IN-SERVICE TESTING OF EQUIPMENT FOR NUCLEAR PLANTS

Moscow IZMERITELNAYA TEKHNIKA in Russian No 5, May 85 pp 62-63

GOLOVASHKIN, M.A., SHERSTYUKOV, N.G., MILEYSHEV, Ye.V., BASKAKOV, N.I., BORISOV, S.Ya. and YAKOVLEVA, V.I.

[Abstract] In order to accelerate the installation of instruments and automatic control in nuclear power and heating plants for operation with a minimum of failures, especially during the difficult initial break-in period, it was necessary to broaden the scope of procedures and documentation for testing all equipment under actual operating conditions. Certification and acceptance will accordingly include in-service monitoring of equipment performance and reliability, additional tests with programmed variation of operating conditions, and certification of computer hardware. These tests are to be performed in accordance with quality control standards devised by a committee which includes representatives of the USSR Ministry of Energy and the USSR Ministry of Instrumentation, Automation and Control Systems as well as representatives of equipment producers and equipment users. Special attention is paid to producer-user interfacing, especially in the pilot production and pilot operation stage. References: 3 Russian.
[303-2415]

DIAGNOSTIC APPARATUS FOR DETERMINATION OF MOISTURE CONTENT IN NUCLEAR POWER PLANTS

Moscow METROLOGIYA in Russian No 11, Nov 84 pp 60-63

SHCHEKLEYN, S.Ye., KUZNETSOV, O.V., VLASOV, S.M. and RAGOZIN, O.A.

[Abstract] Reliable and safe operation of AES equipment as well as maintenance of optimum operating conditions with a two-phase coolant require monitoring principally the moisture content and additionally the flow pattern. A capacitive moisture (vapor) meter has been developed for this purpose which is sufficiently simple for industrial use. Its special transducer is designed for measurement under any condition of coolant flow with maximum noise immunity. It consists of a capacitor formed by the inside surface of the coolant pipe and a cruciform electrode at the pipe axis, both insulated from the coolant by dielectric coatings. The transducer capacitance is uniquely determined by the dielectric permittivity of the two-phase coolant when the mixture is homogeneous (effervescent or emulsive flow), but changes appreciably as the flow becomes ballistic with bubbles covering most of the channel cross-section. This change is caused by the difference between the dielectric permittivity of water and that of its vapor. The higher sensitivity to changes within the boundary layer at the pipe wall is particularly favorable for measurements in an annular stream with one phase finely dispersed. In addition to this transducer, the instrument includes a clock-pulse generator, a pulse shaping RC charge-discharge circuit, an RC trigger on a series KMDP microcircuit chip, an active low-pass filter, a voltage subtractor with scale conversion, an integrator with output indicator, a register, and a voltage-to-current converter for matching the register with the subtractor. The capacitance range of the transducer is 90-2000 pF, its frequency range is 0-150 Hz and conversion from capacitance to an analog signal is linear within 0.5%. Figures 2; references 2: 1 Russian, 1 Western.

[300-2415]

TRITIUM LEAKAGE IN FUSION REACTOR

Moscow ATOMNAYA ENERGIYA in Russian Vol 58, No 2, Feb 85 (manuscript received 30 May 83) pp 111-113

MARTYNENKO, Yu.V. and YAVLINSKIY, Yu.N.

[Abstract] The leakage of tritium through a metal barrier, usually made of stainless steel, in a fusion reactor is treated as a problem of diffusion. In this case it is not easy to establish the true boundary conditions, and it is necessary to include the temperature gradient in the barrier. The mathematical model is constructed accordingly, assuming that the tritium

stream from the plasma is much larger than the tritium stream from the inside barrier surface. The corresponding partial differential equation for the gas concentration in a one-dimensional transient flow in the direction normal to the barrier is solved, assuming approximately zero initial concentration everywhere in the barrier, zero concentration at the outside barrier surface at any time and constant concentration at the inside barrier surface all the time till $t = \infty$. The diffusion coefficient is exactly

$D(x) = D(0)e^{-E_D/T_1 - x \cdot T}$ and approximately $D(x) = D_0 e^{-x E_D T/T_1 T_0}$ (x - space coordinate in the direction of gas flow, E_D - diffusion activation energy, T - temperature gradient in the barrier, T_1 - temperature of inside barrier surface in contact with the plasma, T_0 - temperature of outside barrier surface in contact with the coolant). The general solution is applied to barrier design for the INTOR tokamak, where tritium impinges on the barrier in the form of 100-1000 eV ions with a concentration in the boundary layer reaching 10^{22} - 10^{23} cm $^{-3}$. In a typical case, steady-state flow is reached after a diffusion period of $t_d = (e^{\alpha d} - 1)/\alpha^2 D_0 = 7.5 \cdot 10^6$ s ($\alpha = E_D T/T_1 T_0$, d - thickness of barrier), with the rate of hydrogen and tritium leakage reaching $N(\infty) = 2 \cdot 10^{18}$ cm $^{-2}$ s $^{-1}$ and $q(\infty) = 10^{11}$ cm $^{-2}$ s $^{-1}$, respectively. The authors thank G. Ye. Shatalov for valuable discussions. References 6:

4 Russian, 2 Western.

[287-2415]

UDC 621.039.56:621.039.7

ENSURING RADIATION PROTECTION IN TREATMENT OF RADIOACTIVE WASTE FROM ATOMIC ELECTRIC POWER PLANTS

Moscow ATOMNAYA ENERGIYA in Russian Vol 58, No 2, Feb 85 (manuscript received 10 May 83, in final version 11 Oct 84) pp 113-116

VOROBYEV, Ye.I., ILIN, L.A., BELITSKIY, A.S., PAVLOVSKIY, O.A. and STEPANOVA, V.D.

[Abstract] Radioactive waste from AES is divided into gaseous, liquid and solid components, each requiring a different treatment for environmental protection. The problem is qualitatively and quantitatively analyzed, specifically for AES with water-moderated water-cooled power reactors (VVER) and water-graphite channel reactors (RBMK), as well as fast-neutron reactors (BN) producing liquid and solid radioactive waste. The gaseous waste includes radioactive noble gases, ^3H , ^{14}C , $^{89,90}\text{Sr}$, ^{131}I , and mixtures of other nuclides with a half-life longer than 24 h. The gaseous waste is now most effectively treated by delaying its release into the atmosphere. The liquid waste includes vat residue containing radioactive salts, particularly nitrates (up to 30 g/dm 3 in VVER waste and up to 90 g/dm 3 in RBMK waste) as well as sodium oxalate and sodium ethylenediaminetetracetate (and sodium borate in VVER waste). The liquid waste is stored in tanks made of reinforced concrete with sheet steel lining, but besides ^{106}Ru , ^{95}Zr , ^{95}Nb there also appear here radioactive corrosion products and, in long-stored VVER waste, borate salts as well. Most reactors in the USSR operate with recirculation of

industrial water, which does or can contain radionuclides. Those radionuclides such as tritium in excess water which are often present in traps and drains are usually reduced to safe levels in cooling tanks. The most effective way of treating liquid waste is by solidifying it and fixing the radionuclides it contains so as to prevent their lixivation and escape into the atmosphere. Solid waste includes components with γ - and β -activity ranging from very high to low levels. A major problem is maximizing the utilization of bunker space. Common solutions to this problem are shredding and pressing, melting thermoplastic waste, burning combustible waste, etc. Radiation protection to the safe level applies to the natural environment as well as to sanitary countermeasures; a large role is assigned here to proper choice of waste disposal sites under favorable hydrogeological conditions available in the territory of the USSR. Tables 3; references 9: 8 Russian, 1 Western.
[287-2415]

UDC 539.124:539.125.517.5:681.3.001.24

NEUTRON YIELD FROM THICK TARGETS BOMBARDED BY ELECTRONS OF UP TO 500 MeV ENERGY

Moscow ATOMNAYA ENERGIYA in Russian Vol 58, No 2, Feb 85 (manuscript received 9 Feb 84, in final version 7 Jun 84) pp 120-123

YEMETS, N.L., SHILYAYEV, B.A. and YAMNITSKIY, V.A.

[Abstract] Because of insufficient available physical experimental data on the photoproduction of neutrons by electron bombardment of a target, a mathematical experiment has been performed on the problem of protecting structures against products of nuclear reactions. Accordingly, the photo-neutron yield was calculated for three groups of target materials: 1) light-weight oxygen and aluminum; 2) intermediate iron and nickel; 3) heavy-weight tungsten and lead. Tungsten is used as converter for producing γ -bremsstrahlung on electron beams, iron and nickel as well as aluminum are used for practical experimentation with structural targets, while oxygen and lead are considered for use as ingredients in protective materials. For simulation with an LUE-360 electron accelerator, the energy range of bombarding electrons was selected to be 34-300 MeV, and the target thickness was selected to range beyond $10X_0$ to the thickness at which "saturation" of secondary neutron emission corresponding to this range of electron energy would occur, with X_0 denoting the radiation penetration depth at each given level of electron energy. The calculations were based on the cascade-evaporation model of a nucleus according to the IMITATOR program package, in combination with the fission-evaporation model. Allowance was made for interactions of γ -quanta with a single nucleon and with a quasi-deuteron, respectively, as well as their absorption by the target with attendant generation of electron-positron pairs, also the balancing bremsstrahlung process in accordance with the transport model. These models were checked against experimental data available since 1969; their validation requires an

adequate interpretation of several discrepancies. Calculations on this basis have yielded fairly reliable estimates of the energy distribution and the angular space distribution of photoneutrons. Photoneutrons of energy above 70 MeV in targets of thickness $10X_0$ bombarded by 300 MeV electrons are of most practical interest, as are estimates of the dependence of the photoneutron yield and of the fast-neutron yield on the energy of primary electrons. The results reveal anomalies near magic and doubly magic nuclei. The authors thank Yu.N. Ranyuk for his initiative and participation in modeling the cascade-evaporation process in a nucleus. Figures 6; references 9: 4 Russian, 5 Western.
[287-2415]

UDC 621.039.5.629.1

GAS SATURATION OF COOLANT IN PRIMARY LOOP OF NUCLEAR STEAM-GENERATING PLANTS WITH WATER-MODERATED WATER-COOLED POWER REACTORS

Moscow ATOMNAYA ENERGIYA in Russian Vol 58, No 2, Feb 85 (manuscript received 21 Feb 84, in final version 1 Jun 84) pp 129-130

KALAYDA, Yu.A., LASTOCHKIN, A.P., YESIN, V.I., SYSOYEV, V.S., KATKOV, Yu.D., KHORKOV, M.G., PERFILYEV, G.Ye. and DOBROGORSKIY, V.A.

[Abstract] Available data on the solubility of nitrogen in water reveal an ambiguous temperature dependence of the gas concentration. This has significant implications for the performance of the primary coolant loop, including pumps and filters, as well as of the fuel assemblies. An excessive nitrogen concentration in cooling water, within the 2000-3000 n.cm³ N₂ per kg H₂O range, can be dangerous. The problem is particularly serious in nuclear steam-generating plants, where reliable control of gas concentration in hot coolant is very difficult. In view of this, an experimental study of gas transport and gas saturation in a closed system was made by the compensation method in a special test stand simulating the conditions in the primary loop. The equipment includes a gas tank, a cooling coil, an electric furnace, a main water container and a gas container, a compensation vessel, an expansion vessel, 13 shut-off valves, 2 thermocouples, 3 reference manometers, a set of manovacumeters, and a set of inductive differential transducers with secondary indicating and recording devices. The results have yielded the dependence of nitrogen concentration on the number of heating-cooling cycles over various temperature ranges (300-80°C, 310-210°C, 270-145°C) and, after processing and evaluation with fixed pressure in the expansion vessel, an analytical relation for the gas concentration in the compensating water, dependent on the temperature and the pressure in the compensation vessel and in the expansion vessel as well as on the volume of the latter. The results indicate that, in a nuclear steam-generating plant with a water-moderated water-cooled power reactor, the concentration of compensating gas can be higher in the primary coolant water than in the compensating water. Figures 2; references: 4 Russian.
[287-2415]

DEVICES FOR IRRADIATING FUEL ELEMENTS IN SM-2 and 'MIR' REACTORS UNDER VARIABLE OPERATING CONDITIONS

Moscow ATOMNAYA ENERGIYA in Russian Vol 58, No 2, Feb 85 (manuscript received 28 May 84) pp 97-100

TSYKANOV, V.A., GRACHEV, A.F., KLOCHKOV, Ye.P., KUPRIYENKO, V.A. and SHAMARDIN, V.K.

[Abstract] An irradiating device "Elektropochta" (Electric Mail) has been developed and built for testing fuel elements in an SM-2 reactor, a high-flux reactor with beryllium reflector, during steep changes in the heat release intensity. The fuel assembly is here coupled to a plunger for forward and backward travel over a total distance of 500 mm through the irradiation zone; this electromagnetic plunger is driven by two power windings and its movement being regulated by two control windings. Another irradiating device TTs-SM has been developed and built for testing fuel elements in an SM-2 reactor under varying conditions of operation, right inside the reactor right inside the core rather than by simulation outside. The fuel assembly is here fully equipped with probes, transducers, and measuring instruments. The heat release intensity is regulated by a movable shield which absorbs thermal neutrons. For testing fuel elements in the MIR multiloop research reactor, it is possible to regulate the power of fuel assemblies in some core regions over the range of 80-100% of nominal without disturbing experiments simultaneously performed in other core regions. This is achieved by rotating a fuel assembly in a heterogeneous neutron field and thus periodically varying its orientation relative to a stationary shield which shapes the neutron field inside the TTs-2M irradiating device into a non-uniform one. All three irradiating devices and the respective methods of testing fuel elements have been proven out and are now in use. Figures 7; references 5: 3 Russian, 2 Western. [287-2415]

UDC: 551.464.6+551.510.7

GLOBAL PROPAGATION OF ^{129}I AND PREDICTION OF ITS ACCUMULATION UPON DELIVERY BY NUCLEAR FUEL CYCLE ENTERPRISES

Moscow ATOMNAYA ENERGIYA in Russian Vol 58, No 3, Mar 85 (manuscript received 10 May 84) pp 171-174

STYRO, B.I., NEDVETSKAYTE, T.N. and FILISTOVICH, V.I.

[Abstract] Among the nuclides generated by man which may contaminate the atmosphere is ^{129}I , which has a half-life of about 10^7 years. This nuclide is continuously accumulating in the environment as a result of operation of nuclear fuel cycle enterprises throughout the world. The purpose of this work is to estimate this accumulation, predict its possible

growth and attempt to develop a foundation for requirements for systems for limiting entry of ^{129}I into the environment. The calculations show that ^{129}I entering the environment is scattered in accordance with the patterns of the iodine cycle. Given the present level of the purification factor, practically all ^{129}I by the year 2000 will be located in the mixing layer and deeper layers of the ocean, soil and biosphere. Its content in the terrestrial biosphere will increase by 4-5 orders of magnitude. This requires improvement in the purification devices of nuclear fuel cycle enterprises so that, by the year 2000, the coefficient of purification must be reached $1 \cdot 10^4$ and $1 \cdot 10^5$ for entry of the major quantity of ^{129}I into the mixing layer of ocean and atmosphere, respectively. Burying of radiiodine in the ocean, as suggested in American works, may result in significant concentrations in other reservoirs. Figures 4, references 10: 4 Russian, 6 Western.
[296-6508]

UDC: 621.039.512.4

UNSTEADY MODERATION OF NEUTRONS FROM POINT PULSED SOURCE IN SYSTEM OF TWO MEDIA WITH FLAT INTERFACE

Moscow ATOMNAYA ENERGIYA in Russian Vol 58, No 3, Mar 85 (manuscript received 26 Jan 84; in final form 1 Oct 84) pp 192-194

ZHEMEREV, A.V.

[Abstract] Based on an age approximation, a study is made of the unsteady distribution function of neutrons from a point pulsed isotropic source in a system consisting of two different media with a flat interface. It is assumed that the neutrons are moderated only as a result of elastic collisions, the length of the free path of the neutrons in each medium is independent of energy and there is no absorption of the neutrons. The problem of determining the unsteady distribution function of neutrons moderated in the system of two bodies is reduced to solution of an integral equation at the interface. References 9 Russian.
[296-6508]

UDC 621.311

AUTOMATION OF FEEDWATER LOOP FOR V-1000 BOILER SET IN SOUTHERN UKRAINIAN ATOMIC ELECTRIC POWER PLANT OVER WIDE LOAD RANGE

Kiev ENERGETIKA I ELEKTRIFIKATSIYA in Russian No 1, Jan-Mar 85 pp 15-16

PAVLYSH, O.N., candidate of technical sciences, and REUKOV, Yu.N., engineer, Southern Regional Power System Engineering Administration

[Abstract] The feedwater loop for the V-1000 boiler set in the Southern Ukrainian AES, which includes two DP-3200(2x1600)/185 deaerators and two

PT-3750-75 turbopumps as well as two groups of pressure heads in two main "running" and two auxiliary "starting" feedwater channels, has been automated for operation over a wide load range. The control system consists of a water flow meter and a steam flow meter, both of the disk type, a sampling level gauge in the steam generator, a main "running" feedwater flow regulator, an auxiliary "start-stop" feedwater flow regulator, and sets of VAZ-958-E-01 main and startup regulating feedwater valves. The selection and the setting of all components are based on an analysis of transients attending load buildup and load changes over a wide range as well as stop-start cycles triggered by faults. Special signal transducers of the "Sapfir" class were found to be required for maintaining the feedwater level under 10-30% nominal load as well as under 30-100% nominal load. Figures 2.
[286-2415]

UDC 621.376.234

CONSTRUCTION FEATURES AND CHARACTERISTICS OF COAXIAL NUCLEAR RADIATION Si(Li)-DETECTORS

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 2, Mar-Apr 85
(manuscript received 6 Dec 82) pp 61-64

AFANASYEVA, N.P., PASHUK, L. I. and PUSTOVOYT, A.K., Leningrad Institute
of Nuclear Physics

[Abstract] Experiments to develop large-volume coaxial Si(Li)-detectors are described. The influence of the resistivity and structural defects of the original Si on the characteristics of the devices is investigated. It is found that coaxial Si(Li) detectors are inferior to Ge(Li) detectors because of the high resistivity of silicon. Deep drift of lithium in silicon is analyzed; it is found that the high resistivity of silicon can be overcome by using the appropriate material and construction for the detector, as well as the proper lithium drift conditions. A method is described for obtaining detectors with 2.5-6 keV resolution for the γ -line of ^{137}Cs with a working volume of 30 cm³. The best material from the viewpoint of loss inhomogeneity in drift characteristics is found to be cluster-free silicon grown in an argon atmosphere. Figures 4, references 7: 2 Russian, 4 Western.
[326-6900]

SYSTEM FOR HIGH TEMPERATURE ELECTRON IRRADIATION IN SUPERHIGH VACUUM

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 2, Mar-Apr 85 (manuscript received 12 Mar 84) pp 162-164

ARBUZOV, V.L., DAVLETSHIN, A.E., DANILOV, S. Ye., DOMANSKIY, D.E., KLOTSMAN, S.M. and NIKOLAYEV, A.L., Institute of Metal Physics, USSR Academy of Sciences

[Abstract] A system is described that makes it possible to irradiate specimens under superhigh vacuum conditions (better than 10^{-7} pA) at temperatures of 450-1100 K, and to change specimens quickly without breaking the seal of the working chamber. The system is based on the commercially produced USU-4 universal superhigh vacuum installation. The working chamber of the system is coupled by a bellows to the electron conductor of a LUE-25 linear accelerator. Experiments entailing measuring the temperatures of the middle of the specimens, the holder, and the thermostat body are described. The temperature measurement error was found to be less than 10 K, and the specimen holders can be changed in less than 15 minutes. Figures 2, references 6: 2 Russian, 4 Western.

[326-6900]

TESTING OF SYSTEMS FOR AUTOMATIC REGULATION OF SECOND-LOOP PARAMETERS OF NUCLEAR POWER PLANT EMPLOYING VVER-1000 REACTOR

Moscow ELEKTRICHESKIYE STANTSII in Russian No 6, Jun 85 pp 23-25

PAVLYSH, O.N., Candidate of Engineering Sciences, and GARBUZOV, I.P. and REUKOV, Yu.N., Engineers

[Abstract] The structural diagrams of the basic automatic regulating systems employed in the second loop of the Yuzhno-Ukrainskaya nuclear power plant are presented. Field testing of these systems during start-up is described, including disconnection of the main circulating pump and one of the two working turbine pumps, as well as steam load shedding. The parameter regulating systems are found to be serviceable and to conform to the basic requirements.

[329-6900]

SELECTIVE COATINGS FOR SOLAR-TO-THERMAL ENERGY CONVERTERS

Dushanbe IZVESTIYA AKADEMII NAUK TADZIKSLOY SSR: OTDELENIYE FIZIKO-MATEMATICHESKIKH, KHIMICHESKIKH I GEOLOGICHESKIKH NAUK in Russian, No 2, Apr-Jun 85 (manuscript received 6 Jul 83) pp 69-71

UMAROVA, M.I., Institute of Engineering Physics imeni S.U. Umarov, TaSSR Academy of Sciences

[Abstract] Conventional coatings which absorb solar radiation and reflect intrinsic thermal radiation, for use on solar-to-thermal energy converters, are classifiable into five groups: 1) black metal oxides on polished metal substrates; 2) selective paint consisting of semiconductor particles uniformly dispersed in organic binder; 3) strongly doped semiconductor layers; 4) weakly doped semiconductor layers; 5) interference layers. Earlier the author proposed two-layer combinations of a black oxide under a strongly doped layer of a wideband semiconductor material on the polished surface of a bulky metal substrate. Now the author proposes two-layer combinations of a black oxide under a layer of transparent conducting material on a metal foil as substrate; both layers are produced by a single technological process by the pulverization method and the foil thus coated is easily bonded to the surface of a solar radiation collector of any shape. Pulverization is achieved by spraying the substrate with film-forming solutions which contain the chemical elements of given coating layers. On an aluminum substrate heated to 450°C, for instance, an aqueous solution of $\text{CuNO}_3 + \text{HCl}$ is used to produce the CuO layer, and an alcohol solution of SnCl_4 is used to produce the SnO_2 layer on top. Such coatings with 0.3 μm CuO layers and 0.6 μm thick SnO_2 layers were produced experimentally, examined with an x-ray fluorescence spectrometer, and then tested mechanically after exposure to the sun in the Tajik mountains for 150 days at 2500 m altitude (1000 kW.h/m²) and 25 days at 4500 m altitude (250 kW.h/m²). An absorption coefficient of 0.60-0.67 and an emissivity of 0.13-0.15 in the solar spectrum were achieved with a single CuO layer, with the absorption coefficient increasing to 0.90 and the emissivity increasing to 0.20-0.30 with an SnO_2 layer on top. The coatings were found to have high adhesion strength and high mechanical stability as well as high heat and moisture resistance. In addition, their cost is low. Figures 1; tables 1; references 4: 2 Russian, 2 Western. [249-2415]

IMPROVING COMBUSTION OF LOW-GRADE FUELS BY THERMOCHEMICAL PROCESSING

Minsk IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: ENERGETIKA in Russian No 3, Mar 85 (manuscript received 28 Feb 84) pp 96-100

CHMEL, V.N., candidate of technical sciences, DUNAYEVSKAYA, N.I., engineer, and OGIY, V.N., engineer, Institute of Simulation Problems in Power Engineering, UkSSR Academy of Sciences, BARBYSHEV, B.N., engineer, Institute of Engineering Thermophysics, UkSSR Academy of Sciences

[Abstract] The economics of power generation in the Ukrainian SSR require that low-grade fuel, characterized by low heating value and high ash content, be upgraded for effective use in combination with high-grade fuels such as residue oil or natural gas. In the case of coal dust, dust of anthracite or leaner bituminous coal, with a low content of volatile matter one method of improvement is two-stage combustion, first with 0.4-0.8 excess air and then afterburning with 1.6 excess air. Another method of improving the combustion of dust is thermal preprocessing. This is now done by heating the aerosol close to ignition with the products of oil or gas combustion and then injecting it in this state into the furnace. A more effective method would be to preheat the aerosol to higher temperatures, but so as to avoid self-ignition. This can be achieved by thermochemical treatment involving partial gasification, preferably in a stream of gas so as to maximize the gasification rate and, under pressure higher than 2 MPa, also the volumetric efficacy. Such processing will also ensure minimum dependence of the gasification rate on the grade and the quality of coal as well as fastest heating of the fuel particles. A comparative analysis of the combustion thermodynamics in accordance with the diffusion-kinetic theory indicates appreciably higher flame temperatures as well as much higher combustion rates and values of the kinetic constant with than without thermochemical processing. Typically, thermochemical processing of grade ASh with 23% or even 40% ash content can reduce the annual consumption of residue oil for heating a TP-230-3 boiler to one half. Figures 3; tables 1; references 14: 8 Russian, 6 Western. [276-2415]

UDC 662.472

SOLAR RADIATION COLLECTOR-CONCENTRATOR SYSTEM OPERATING IN RADIATION MODE

Ashkhabad IZVESTIYA AKADEMII NAUK TURKMENSKOY SSR: SERIYA FIZIKO-TEKHNICHESKIKH, KHIMICHESKIKH I GEOLOGICHESKIKH NAUK in Russian No 1, Jan-Feb 85 (manuscript received 6 Jun 83) pp 93-95

BAUM, I.V., KORPEYEV, N.R. and BEGENCHEV, B., Scientific-Industrial Association "Solntse" and TuSSR Academy of Sciences

[Abstract] The performance of a solar radiation collector-concentrator system with the concentrator in the focal plane of a paraboloidal mirror is

analyzed on the basis of the equation of steady-state heat balance at the boundary of the radiation-collecting surface $KJ_0\alpha_s = \epsilon_r\sigma T_r^4 + q_0$ (K - geometrical concentration coefficient, J_0 - intensity of solar radiation, α - reflection coefficient of mirror surface, α_s - absorption coefficient of collector surface, ϵ_r - emissivity of collector surface, q_0 - density of thermal flux penetrating the vessel wall, σ - Stefan-Boltzmann constant). The calculations are based on two approximations, namely that the high thermal conductivity of the vessel material makes it possible to assume a uniform temperature distribution T_r over the entire collector surface and that q_0 is so small in comparison with the other two terms as to make the latter equal to one another. The second approximation yields a constraint on the thermal insulation of the collector vessel, namely that its thickness ensures such a condition. This thickness is proportional to the thermal conductivity of the insulation material and to the ratio of insulation surface area S_1 to collector surface area S_c . From the standpoint of design, this ultimately requires increasing the concentrator surface for an overall size reduction. A correction in the design formula needs to be made by subtracting from the ideal optimum insulation thickness an amount which accounts for the mean insulation temperature. The dependence of q_0 and of the insulation temperature on the insulation thickness has been evaluated on this basis for a typical compact collector vessel with $S_1/S_c = 6$ and $T_A = 2000$ K. Figures 2; references: 2 Russian. [248-2415]

UDC 621.184.54:536.24

EFFECT OF HEAT TRANSFER NONUNIFORMITY ON LOCAL TEMPERATURES IN TUBING OF BOILER-ROOM AIR PREHEATERS

Minsk IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: ENERGETIKA in Russian No 4, Apr 85 (manuscript received 2 Mar 83) pp 101-105

MIGAY, V.K., doctor of technical sciences, and YAMPOLSKIY, A.Ye., engineer, Scientific-Industrial Association imeni I.I. Polzunov

[Abstract] The problem of nonuniform convective heat transfer is formulated for tubing in boiler-room air preheaters. The assumption of a constant thermal flux cosinusoidally distributed around the tube circumference combined with dimensional analysis, which yields the relation $Nu = 0.021 Re^{0.8} Pr^{0.43}$, leads to a heat transfer and temperature nonuniformity factor of $\epsilon = 205 \cdot \frac{1}{2} Re^{-0.855} Pr^{-0.613}$. The problem is formulated taking into account heat conduction through the metal and assuming different constant heat transfer coefficients outside and inside the tube. The second-order ordinary differential equation of heat transmission for a hollow cylinder, with, correspondingly, one conduction term and two convection terms on the left-hand side, is solved by the standard method. The solution indicates that the nonuniformity of thermal flux around the outside surface does not differ significantly from the nonuniformity of heat transfer coefficients around both the outside and inside surfaces. The method can therefore be used for evaluating the effect of nonuniformity outside on the nonuniformity inside. The equalizing effect of heat conduction reduces the nonuniformity

typically from $\{\sigma = 2$ outside to $\{\sigma = 1.5-1.7$ inside. Figures 2; tables 1; references 5: 4 Russian, 1 Western.
[254-2415]

UDC 621.224.7

DEPENDENCE OF RADIAL FORCE IN REVERSIBLE HYDRAULIC MACHINE ON OPENING OF GUIDE VANES

Minsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ENERGETIKA in Russian No 4, Apr 85 (manuscript received 18 Jul 84) pp 106-109

GUSHAN, Ye.T., engineer, PROVAD, Ye.B., engineer, and UMOV, V.A., candidate of technical sciences, docent, "Order of Lenin" Leningrad Polytechnic Institute imeni M.I. Kalinin

[Abstract] Following an experimental design and performance study of reversible turbomachines for the Zagorsk pumped-storage hydroelectric power plant, the dependence of the radial force on the opening of the guide vanes is evaluated theoretically on the basis of computer-processed data. Both the static and the radial components of the runner force are covered over the entire 4-40 mm range of guide vane opening, namely from an opening smaller than for idle run to an opening for 95% of full load. Graphical calculation of the total force involves drawing the vectors of the averaged radial force, which represent its static component, along constant-opening lines in the speed-flow plane. This has been done for a machine operating as a plain pump, in the near-pumping counterflow mode, in the nonflow transition mode, as a turbine, as a brake, and as an active pump. The resultant vector is found to rotate in the plane of action regardless of the operating mode except nonflow. The results reveal that both components of the radial force reach their maximum at the maximum guide vane opening and are then larger in the brake mode than in any other. The article was presented by Department of Hydraulic Machinery. Figures 1; references 4: 3 Russian, 1 Western.
[254-2415]

CHARACTERISTICS OF WATER CONDITIONING IN 200 MW POWER UNITS OPERATING WITH REGULATION OF LOAD CURVE ON ELECTRICAL SIDE

Minsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ENERGETIKA in Russian No 4, Apr 85 (manuscript received 1 Dec 83) pp 61-65

VYSOTSKIY, S.P., candidate of technical sciences, and RYZHIKOVA, N.V., engineer, All-Union Institute of Heat Engineering imeni F.E. Dzerzhinskiy, Southern branch

[Abstract] Water conditioning was studied on a 200 MW unit of the Starobeshevo GRES, where a K-200-130 steam turbine and a TP-100 boiler operate with regulation of the load curve on the electrical side. The concentrations of scale-forming silicic acid and phosphates in the boiler water as well as the alkalinity of the latter were measured, as well as the concentration of silicic acid in the saturated steam, while corrosion products were monitored. Measurements were made over 24 h cycles in the various seasons of the year characterized by different load curves. The normalized and evaluated data confirm the expediency of condensate purification, indicating also that loading the power unit at a rate 3-5% faster than nominal effectively reduces migration of silicic acid into the turbine channels. Figures 2.

[254-2415]

HIGH-MOUNTAIN TESTING OF SELECTIVE OPTICAL COATINGS FOR RADIATORS AND COLLECTORS IN SOLAR POWER PLANTS

Dushanbe IZVESTIYA AKADEMII NAUK TADZHIKSKOY SSR: OTDELENIYE FIZIKO-MATEMATICHESKIKH, KHIMICHESKIKH I GEOLOGICHESKIKH NAUK in Russian No 1, Jan-Mar 84 (manuscript received 6 Jul 83) pp 77-79

UMAROVA, M.I., Institute of Engineering Physics imeni S.U. Umarov, TaSSR Academy of Sciences

[Abstract] Field tests under severe high-mountain conditions were performed on several coatings for radiators and collectors in solar power plants. The coating materials were: 1) organosilicon varnish as binder with white powder as filler; 2) Al_2O_3 embedded in water glass; 3) glass film with reflective aluminum backing; 4) electrochemically tinted Al_2O_3 with SnO_2 layer; 5) high-vacuum-deposited 100-200 Å thick nickel plus 800-1000 Å thick SiO_2 ; 6) low-vacuum-deposited black aluminum; 7) galvanically deposited black nickel; 8) vapor-deposited $CuO + SnO_2$; 9) spray-deposited CuO and $CuO + SnO_2$. All coatings were deposited on metallic aluminum substrates, rough, ground, or polished blocks, or plates, or foils, except black nickel deposited on carbon ribbon. They were held for 150 days (including 100 sunny

days) at 2500 m above sea level, with the ambient temperature varying over the $-4-(+28)^{\circ}\text{C}$ range, and took in a total 1000 kW.h/m^2 dose of solar radiation at this altitude. They were held for 25 days (including 21 sunny days) at 4050 m above sea level, with the ambient temperature varying over the $-4-(+12)^{\circ}\text{C}$ range, and took in a total of 250 kW.h/m^2 dose of solar radiation at this altitude. The portable square test box was made of sheet steel, $420 \times 420 \text{ mm}^2$ large and 114 mm high, with a $360 \times 360 \text{ mm}^2$ large glass pane in the lid. Specimens were placed inside, 20 mm below the window on a 10 mm thick plywood board. The temperature inside was monitored with a thermometer, while the absorption coefficient and the thermal emissivity were measured. The results indicate that Al_2O_3 embedded in water glass will after 7 days in outer space behave like glass with aluminum backing. Double-layer coatings such as $\text{CuO} + \text{SnO}_2$ are optically most stable, their absorption coefficient and thermal emissivity not having changed significantly at all, and can be recommended for solar radiation collectors in high mountains. Figures 1; tables 1; references 2: 1 Russian, 1 Western. [285-2415]

FIRST USSR SOLAR ELECTRIC POWER PLANT

Kiev ENERGETIKA I ELEKTRIFIKATSIYA in Russian No 1, Jan-Mar 85 pp 20-21

GALUSHCHAK, V.S., engineer, Department of Economic Planning, Crimean Regional Power System Administration

[Abstract] The first experimental 5 MW solar electric power plant in the USSR, located near the Azovskoye Selo in the Leninsk rayon of the Crimean oblast, contains SES-5 equipment designed for solar radiation flux density up to 0.7 kW/m^2 and 2000 hours of operation in a year. The plant has a tower-type layout with the solar steam generator at the center of the mirror field on top, which prevents mutual shadowing of heliostats. The mirror array covers an area of $40,000 \text{ m}^2$, consisting of azimuthally and elevationally rotatable 25 m^2 large glass panes mounted in a metal frame and forming a separately standing column. The mirror field is built up by concentric circles of heliostats, a total of 1600 units, forming a ring with a 150 m inside diameter and a 435 m outside diameter. The steam generator, in the shape of a hexadecahedron inscribed in a circle approximately 7 m in diameter, consists of plane integrally welded 1.4 m wide and 8.8 m high vertical 2 economizer tube panels and 14 evaporator tube panels. It generates steam at 40 atm and 250°C , at rates up to 28 t/h when all heliostats are operating. A separator-superheater inserted between the high-pressure stage and the low-pressure stage of the PT-12 turbine set ensures 100% steam quality. The turbine condensers operate with a dry cooling tower. Storage of hot water is provided for reserve during fast changes of solar radiation intensity. [286-2415]

SUITABLE INSULATOR DESIGNS FOR SEVERE OPERATING CONDITIONS

Kiev ENERGETIKA I ELEKTRIFIKATSIYA in Russian No 1, Jan-Mar 85 pp 32-35

GAYDASH, B.I., candidate of technical sciences, State Design Institute for Electrical Equipment Industry, Slavyansk branch

[Abstract] Existing insulators for overhead electrical transmission lines, while otherwise reliable, do not necessarily have an adequate dust resistance and thus require periodic cleaning. A comparative study was, therefore, made for the purpose of selecting or developing the optimal insulator construction and thus minimize the dust accumulation problem. A theoretical analysis has revealed that conical insulator dishes have favorable aerodynamic characteristics. This hypothesis was verified experimentally on PS6 and PF6 insulators. These insulators were also found to have by far the highest dust resistance, based on tests in dusty air stream for six hours within which aerodynamic equilibrium was reached and the dust accumulation peaked. The smooth conical dish surfaces of PF6-1, PS16-1, PS6-1 insulators was found to be particularly favorable. Since 1979 there are in the Nebit-Dag regional power system 98,900 PF6-1 insulators carrying the wires of 110 kV transmission lines and 12,620 PF6-1 insulators carrying the wires of 35 kV transmission lines. In the Donbass regional power system there are 5,000 PF6-1 and PS6-1 insulators. Laboratory and intermediate factory tests, followed by mass production of insulators with conical dish surfaces, indicate that porcelain and glass have excellent technological characteristics for this application. Accordingly, efforts are under way to mechanize and automate the production of such insulators. With these insulators, the operating cost of an electric power distribution network is expected to decrease by at least 2 million rubles annually. Figures 3; tables 1; references: 5 Russian.
[286-2415]

DC 338.658.621.311

EFFECTIVENESS OF REGULATING ELECTRIC POWER CONSUMPTION BY FEEDWATER PUMPS IN 200 MW POWER UNITS

Kiev ENERGETIKA I ELEKTRIFIKATSIYA in Russian No 1, Jan-Mar 85 pp 18-20

DIKMAROV, S.V., doctor of economic sciences, and AKINSHINA, Ye.V., engineer, Lvov Polytechnic Institute

[Abstract] A study made in the Scientific Research Laboratory NIL-14 at the Lvov Polytechnic Institute and pertaining to available power in the Burshtyn GRES during load peaks has established that regulating the consumption of electric power by the PEN-430-180 feedwater pumps for all twelve 200 MW units can make appreciably more power available for covering the peak load. Such a regulation is achieved by pairwise hookup of feedwater loops and steam loops of adjacent two power units so that during load peaks three instead of

four pumps are needed for feeding the boilers of those two power units now operating in parallel. The saving in power consumption was estimated on the basis of plant and pump performance analysis, including plant shutdown and probability of pump failure during the most severe winter and summer seasons with an either 1% or even 2% mean fault rate. Effectiveness in terms of plant capability is directly related to fuel economy and cost effectiveness. A release of extra 2.7 MW for coverage of a 16.2 MW peak load by the Burshtyn GRES has saved the Lvov electric power plant 836,900 rubles in one year, while costing the Burshtyn GRES an extra investment of only 91,500 rubles. Tables 3; references: 1 Russian.
[286-2415]

UDC: 629.12.034

PROSPECTS FOR USE OF NONTRADITIONAL POWER SOURCES ON SHIPS AND FLOATING STRUCTURES

Leningrad SUDOSTROYENIYE in Russian No 3, Mar 85 pp 3-4

CHETYRKIN, A.N.

[Abstract] A discussion of various unconventional renewable energy sources which could be used for ships at sea and other floating structures is presented. Modern airfoils (sails) can reduce ship fuel consumption by 20 to 20%. Solar cells are not yet efficient and inexpensive enough to make a practical contribution. The energy of ocean currents might be used for small stationary structures not requiring large amounts of power. Devices utilizing the energy of the waves are not suitable for use on board ships due to their great size and low efficiency. Plants utilizing the temperature difference between the upper warm and lower colder layers of water can be used in equatorial areas, though their efficiency is as yet quite low. Wind energy is therefore the most probable nontraditional source of supplementary power for use on ships. Figures 2, references 6: 5 Russian, 1 Western.

[295-6508]

UDC: 629.12.034

POSSIBILITY OF USING WIND ENERGY TO MOVE TRANSPORT VESSELS

Leningrad SUDOSTROYENIYE in Russian No 3, Mar 85 pp 4-8

MIKHAYLOV, M.V.

[Abstract] Many centuries of ship-building history prove the possibility of ship travel under sail. However, wind energy density is generally small, quite unreliable and at times dangerously high. Wind energy can be applied either by direct conversion to thrust as in traditional sailing vessels or by conversion of its kinetic energy to electrical or mechanical energy by wind motors. Indirect conversion by wind motors can be shown to require devices equal in size to the ship itself, and is therefore impractical. The

requirements for a sailing ship are outlined. A tanker with a displacement of about 7,000 tons was selected as a test case for a design of a motor sailer utilizing both wind and conventional engine power. The results of computer simulation and tow testing of models show that, under favorable conditions as in the North Sea at winter, sails could achieve a fuel saving of about 30%. Under more realistic conditions, the actual savings could be 5 to 13%. The wind is therefore a promising source of supplemental energy for commercial shipping. Figures 6, references 5: 4 Russian, 1 Western. [295-6508]

UDC: 629.12.034

MODERN WIND POWER SOURCES FOR SHIPS

Leningrad SUDOSTROYENIYE in Russian No 3, Mar 85 pp 8-14

KUZMENKO, A.V.

[Abstract] In spite of the dominance of power over sail in ships at sea, sailing vessels have never been completely replaced by motor vessels. Several examples of modern wind-powered vessels are noted, and photographs and drawings presented. Vessels discussed include coastal fishing and transport vessels with soft supplementary sails, true sailing vessels including a large four-masted liner with self-tending Marconi rigs, full-length keels and space rudders, rigid metal sail transport vessels designed in Japan and England and the Calypso II research vessel with vertical-axis wind wheels. Figures 13, references 15 Western. [295-6508]

UDC: 629.12.034

DECREASING FUEL CONSUMPTION BY THE USE OF SAILS ON A SMALL TANKER

Leningrad SUDOSTROYENIYE in Russian No 3, Mar 85 pp 14-17

ALCHUDZHAN, G.A.

[Abstract] An experimental 'Drogobych'-class tanker with a displacement of 5,400 t was selected as the basis for calculation of fuel savings for 6 operating lines. The versions studied included the installation of rigid rectangular 'Japanese' bent plate sails, two Flattner rotors with end disks and two Bermuda soft sails. No additional ballast or reduction in cargo capacity of the ship was assumed. The calculations considered the additional drag on the ship with increasing wave height as wind increased. It was found that addition of sails provided a 3 to 19% decrease in fuel consumption, the least improvement being in summer, the most in winter. The rotor equipment was found to be most effective, and had the least area, thus obstructing forward vision the least. Figures 4, references 6: 5 Russian, 1 Western. [295-6508]

OPERATIONAL RELIABILITY AND REPAIRABILITY OF SHIP WIND ASSISTANCE SYSTEMS

Leningrad SUDOSTROYENIYE in Russian No 3, Mar 85 pp 17-18

MITRYSHKIN, Yu.D.

[Abstract] In analyzing the reliability and repairability of various ship wind-driven assistance systems (sails, rotors, etc.), it is necessary to consider every element of the system, including such factors as the percentage of time each element must be in motion (greater for rotational supplementary power generation systems, less for sails). Such factors as the increase in water resistance resulting from the angle of heel of a sail-assisted vessel and the relative unavailability of repair facilities for nontraditional ship equipment must also be considered. Marine safety factors must also be considered: in many areas, traffic is dense, channels are narrow and it is impossible for a ship to travel in any direction (as determined by the wind) at any speed. The need to stay with channels and maintain fixed speeds may make wind assisted vessels inconvenient or even unsafe. References 7: 4 Russian, 3 Western.
[295-6508]

DIAGNOSIS AND PREDICTION OF TECHNICAL CONDITION OF ROLLING-SURFACE BEARINGS FROM ACOUSTICAL VIBRATION CHARACTERISTICS

Leningrad SUDOSTROYENIYE in Russian No 3, Mar 85 pp 21-23

BARKOV, A.V.

[Abstract] Defects in rolling-surface bearings influence the sound made by bearing-supported units in machinery. Diagnostic instruments designed to listen for the characteristic sounds of various types of bearing defects are among the most sensitive diagnostic devices presently available. However, the instruments presently available have difficulty with bearing units having several types of defects at the same time. Monitoring of the levels of spectral components in the envelope of high frequency random vibration can detect and identify defects which determine the operating life of rolling surface bearings. Figures 2, references 8 Russian.
[295-6508]

CONTENT AND STRUCTURE OF SHIP MAINTENANCE AND REPAIR SYSTEM

Leningrad SUDOSTROYENIYE in Russian No 3, Mar 85 pp 43-45

CHAPKIS, D.T.

[Abstract] The definition of a ship maintenance and repair system has been refined in the Soviet State Standards. The new definition, contained in State Standard GOST 24166-80, defines technical maintenance and repair as 'a set of interrelated technical devices, materials, documents and personnel, necessary and sufficient for maintenance and restoration of assigned values of technical and operational characteristics of ships included in the system.' This definition for the first time includes the word 'sufficient,' which indicates that the system should be economical in terms of expenditures. Secondly, analyzing maintenance and repair as a queueing system, it is concluded that there are both direct and feedback connections between the ships and the system. The actions occurring in the maintenance and repair system are broken down into three groups: input, establishing the requirements for servicing of ships; systems, determining the effectiveness and quality of maintenance and repair; and output, determined by the effectiveness of the system. A flow chart outlines the operation of a typical maintenance system, interrelating all the units in these three groups. This structure can aid in developing the structure of a typical maintenance and repair system for ships of any type. Figure 1, references 6 Russian. [295-6508]

LAW OF INTERACTION BETWEEN EXTENSIVE UNDERGROUND EQUIPMENT AND SURROUNDING SOIL DURING STRONG LONGITUDINAL DYNAMIC EXTERNAL ACTION

Tashkent IZVESTIYA AKADEMII NAUK UZBEKSKOY SSR: SERIYA TEKHNICHESKIKH NAUK
in Russian No 1, Jan-Feb 85 (manuscript received 29 Dec 83) pp 35-39

SULTANOV, K.S., Institute of Mechanics and Earthquakeproof Equipment imeni
M.T. Urazbayev, UzSSR Academy of Sciences

[Abstract] The interaction of extensive underground equipment with the surrounding soil during longitudinal dynamic external action, generally producing a shear stress at the contact surface which is a function of their absolute displacements and their velocities, is analyzed on the basis of the seismodynamic theory with the hypothesis of plane sections for the case of strong action along the axis of the equipment. After the state of stress and strain has been determined accordingly, experimental data pertaining to buried pipes and cables as well as results of static tests are generalized into a law governing the shear stress kinetics with the reversibility of strains in rigid equipment or the viscoelasticity of brittle equipment taken into account. The shear stress τ varies accordingly as an exponential function of time $\tau = A(1 - e^{-Bt})$ ($d\tau/dt > 0$) when it is within the $\tau_{\text{limit}} > \tau > \tau_{\text{soil}}^{\text{limit}}$ range and drops to $\tau = \tau_{\text{soil}}^{\text{limit}}$ ($d\tau/dt \leq 0$) when it is $\tau = \tau_{\text{soil}}^{\text{limit}}$ or to $\tau = G_{\text{slu}} \bar{u}$ (G_{slu} - modulus of longitudinal shear of soil during unloading, \bar{u} - relative displacement between equipment and soil) ($d\tau/dt < 0$) when it is $\tau \leq \tau_{\text{soil}}^{\text{limit}}$. Figures 2; references: 5 Russian. [301-2415]

ACOUSTIC VIBRATIONS OF BEAMS AND PLATES

Dushanbe IZVESTIYA AKADEMII NAUK TADZHIKSKOY SSR: OTDELENIYE FIZIKO-MATEMATICHESKIKH, KHIMICHESKIKH I GEOLOGICHESKIKH NAUK in Russian No 2, Apr-Jun 85 (manuscript received 28 Nov 83) pp 28-33

ZAKHAROV, A.V., FAZYLOV, A.R. and PIRNATOV, R.Kh., Tajik Polytechnic Institute

[Abstract] Acoustic vibrations of any structural member in a building are treated as consisting of those excited at any given instant of time and those excited earlier but then multiply reflected back. The latter vibrations are much more intricate, inasmuch as they involve interference patterns, and are analyzed here on the basis of the simplest two models. The first model is a straight beam with free ends, in which energy is lost by internal friction only. The second model is a straight beam with semireflecting ends formed by 90° bends, with energy being lost here partly by internal friction and partly by dissipation through the ends. The amplitude of the vibrations anywhere along the spectrum between resonance and antiresonance is in each case determined from the energy loss. The problem is solved with the mathematical apparatus of geometric progressions. Figures 4; references:

1 Russian.

[249-2415]

UDC 641.51.06.004+628.517

MODELING OF NOISE CHARACTERISTICS OF MACHINERY

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 3, Mar 85 (manuscript received 25 Sep 84) pp 154-157

ZAPLETNIKOV, I.N., Docent

[Abstract] A method is presented for deriving mathematical models for the noise characteristics of machinery by computer. A regression program is run on a YeS 1020 computer in order to analyze the type of regression model for the same machine noise characteristic. The selection criterion for the model is the multiple correlation coefficient and the standard deviation; only adequate models were examined. The optimization parameter was the machine sound level, the sound power level, or the sound pressure level at the geometric mean frequencies. The experimental design method for constructing models of machine noise characteristics was tested on an MV-35M food mixer. The use of models of machinery noise characteristics makes it possible to analyze them quantitatively, to determine the minimum noise level, and to optimize the search for design treatments to improve noise characteristics. References: 4 Russian.

[6900/46]

UDC: 621.923

THE VMI-250 VIBRATION INSTALLATION

Kiev TEKHNLOGIYA I ORGANIZATSIYA PROIZVODSTVA in Russian No 3, Jul-Sep 84 pp 21-23

BUKARANOV, Yu.N., LUBENSKAYA, L.M. and ARTAMONOVA, T.N., Engineers.

[Abstract] The Voroshilovgrad Machine Building Institute has developed the VMI-250 high frequency (up to 3,000 vibrations per minute) vibration installation, designed for cleaning part surfaces to remove scale, corrosion and mold; for removal of flash and burrs; for decorative grinding and polishing of part surfaces as they are prepared for application of protective and decorative galvanic and paint-varnish coatings; and for hardening of the

surface layers of parts. Ferrous and nonferrous metals and alloys can be treated with the VMI-250 in chemical solutions determined by the physical and mechanical properties of the parts being treated. The VMI-250 is a modular device consisting of a dry unit, vibrating reservoir with a capacity of 250 liters mounted on springs and a frame. Straps with oscillation dampers are attached to the reservoir to prevent excessive vibration at the resonant frequency as the device is started up or shut down. Rubber disk-type vibration-absorbing mounts are used to support the device and reduce the vibration of the floor. Figure 1.
[290-6508]

UDC: 620.178.1

ELECTROACOUSTICAL HARDNESS TESTING OF COMPLEX SHAPED PARTS

Kiev TEKHNLOGIYA I ORGANIZATSIYA PROIZVODSTVA in Russian No 3,
Jul-Sep 84 p 55

URETSKIY, Yu.I., Engineer, SMELYANSKIY, R.M., Candidate of Technical Sciences and KAUBRAK, L.L., Engineer

[Abstract] The Rostov Scientific Research Institute of Machine Building Technology has developed a portable electroacoustical hardness meter, the PKN-66, and a modified version called the TEA-3. Testing is performed using an electroacoustical transducer with a diamond indenter. Manual and automatic operation are provided. The PKN-66 can drive an automatic hardness marker and also a visual indicator. Readout is in HRC or HV units. The device can be used to test the hardness of the inside surfaces of rings at least 300 mm in diameter, as well as the outside surfaces of shafts, pipes and rings 50 to 1500 mm in diameter. The devices have been proven in use to be fast, accurate, portable and reliable. Figure 1.
[290-6508]

UDC: 669.248

ULTRASONIC INTENSIFICATION OF BRIGHT NICKEL PLATING

Kiev TEKHNLOGIYA I ORGANIZATSIYA PROIZVODSTVA in Russian No 3, Jul-Sep 84
pp 58-59

LOGVINENKO, L.F. and ROZDAYBEDA, L.V., Engineers.

[Abstract] The influence of ultrasonic oscillation on the process of surface preparation and the effectiveness of ultrasonic intensification of the application of a galvanic nickel coating were studied. A type UZG2-10 generator and PMS6-22 magnetostriction transducer with a frequency of 16-22 kHz were used. Degreasing and application of the nickel coating were

performed in vinyl plastic ultrasonic baths with the magnetostriction transducers built into the side walls (for degreasing) and bottom (for application of the coating). Power consumption was 2.5 kW at 0.6 W/cm². The use of ultrasound allows a current of 3 to 20 A/dm² during nickel plating (as opposed to 1-5 A/dm² without ultrasound). The rate of precipitation of the nickel increases from 0.2 - 1 micrometers per minute to 2 - 4 micrometers per minute at 8 - 20 A/dm². The precipitates produced were smooth, crystalline in structure without dendrites. The bond strength was good, with no porosity with a coating thickness of 9 - 20 micrometers. The use of ultrasound allows the plating cycle duration to be reduced by a factor of 2 to 3, quality significantly increasing and the rate of precipitation of nickel plating increasing by a factor of 5 to 10. The productivity of galvanic baths is increased and quality of the electrolytic coatings improved.
[290-6508]

UDC: 681.5.65.011.56

FORMATION OF OPTIMAL PLAN FOR ROBOT SYSTEM

Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA
in Russian No 2, Feb 85 (manuscript received 13 Jan 82) pp 53-61

ROKOTOV, V.P.

[Abstract] A study is made of the problem of developing an optimal plan for a robot system which is to perform operations (work), the number of which, sequence of their performance and initial durations are known. Based on the plan with known types and quantities of resources, the problem is to formulate a new plan having the minimum duration. The costs of the resources used must be minimized and distributed uniformly over the optimal interval of operation of the system. The problem is actually more general. Its solution can be used wherever the problem is one of economical and rational utilization of limited resources. It is essential in this case that the economy of resources be analyzed only in the planning stage. Figure 1, reference 1 Russian.
[292-6508]

UDC: 519.6:007.52

ONE APPROACH TO DESIGN OF WELDING ROBOT TO SERVICE CONTINUOUSLY MOVING CONVEYOR

Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA in
Russian No 2, Feb 85 (manuscript received 28 Apr 82) pp 61-66

TKACHEV, A.M., and SIBRIN, A.P.

[Abstract] A study is made of some of the problems related to the creation of robots for servicing of moving conveyors. The welding robot must pick up a

part, carry the part to the proper point on the object being assembled, hold the part steady relative to the object for the time necessary to attach the part to the object and return to its initial position to pick up the next part. The problem is shown to be nonregular and impossible to solve by known methods of the theory of optimal control. A numerical method is suggested for solving the problem of synthesis of controls, and its convergence is proven. The results of numerical modeling confirming the suitability of the method are presented. The algorithm can be used to solve stochastic problems of robot control or problems with incomplete information. The control obtained in this case can serve as an initial approximation for subsequent adaptation of the robot. Figures 5, references 2 Russian.
[292-6508]

UDC: 629.78.051.527

SYNTHESIS OF AN INVARIANT SYSTEM FOR STABILIZING MAGNETIC SUSPENSION

Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA in Russian No 2, Feb 85 (manuscript received 28 Jul 82) pp 67-73

KRAPIVIN, V.S., VOSTRIKOV, A.S.

[Abstract] A study is made of the principles of design and some of the results of experimental study of a system for stabilizing a magnetic suspension having the properties of invariance to signal and parameter disturbances over a broad range of their variation. The object of control is a magnetic support containing an electromagnet and a suspended ferromagnetic device. The comparatively simple stabilization system is constructed on the basis of the principle of localization with organization of subdiscontinuous or discontinuous control, and has predetermined dynamic properties over a broad range of change of disturbances and state variables. When high-frequency self-excited oscillations are organized, the system becomes 'coarser' and less critical to small quantities of inertia and the influence of signal and parameter disturbances, and less sensitive to noise. Inclusion of an integrator in parallel with the amplifier increases the property of invariance of the stabilization system to disturbances. Figures 4, references 4 Russian.
[292-6508]

SYSTEM FOR ADJUSTING GAP IN ELECTROMAGNETIC SUSPENSION WITH INERTIAL CURRENT FEEDBACK

Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA in Russian No 2, Feb 85 (manuscript received after revision 24 Dec 82) pp 118-120

NIKITENKO, Yu.A.

[Abstract] The purpose of this work was to determine the need to use inertial current feedback based on the current of the electromagnet in systems for automatic regulation of the gap of an electromagnetic suspension system to eliminate the negative influence of inertia in computation of control actions on the operation of the system. The use of indirect differentiation devices is found to introduce errors to the system resulting from the presence of inertia in the computation. The negative influence of errors can be eliminated by introducing an inertial feedback with respect to the electromagnetic current if the feedback time constant is equal to the system time constant, which is equal to $1/K$. Figures 2, reference 1 Russian.

[292-6508]

UDC: 669-493.004.3:621.86
669-493.004.8

MECHANIZATION OF CLEANUP, TRANSPORTATION AND PROCESSING OF CHIPS

Moscow MASHINOSTROITEL in Russian No 3, Mar 85 p 17

POLONSKIY, E.B., Engineer

[Abstract] The Planning, Design and Technological Institute of Rostov-On-Don has developed a system for collection, transportation and processing of chips, including branch and main line conveyors and a chip-processing point. The branch conveyors are double-screw conveyors; the main line conveyors are plate-type conveyors. The entire system is controlled from a central point. The chip processing point includes a chip crusher, centrifuges, a briquette press and transport equipment. Full mechanization of the entire chip process will require machine tools which automatically collect the chips and start them on their way down the conveyor train.

[289-6508]

INDUSTRIAL ROBOT CLAMPING DEVICE

Moscow MASHINOSTROITEL in Russian No 3, Mar 85 pp 17-18

FRIDEV, M.Ya., YUGOV, S.G., Engineers, and POTEKIN, V.I., Candidate of Technical Sciences.

[Abstract] The gripper described is intended to grasp circular blanks in its articulated jaws. It is distinguished by the fact that the force coupling between the pneumatic cylinder piston and the jaws is through a nonstopping screw. The jaws automatically adjust to the diameter of the piece being moved, and clamping force is not transmitted to and therefore does not deform the gripper or arm of the robot. The gripper is thus protected from excessive mechanical loading which might be transmitted to the robot, allowing increased accuracy.

[289-6508]

UDC: 62-236.58

A GRIPPER

Moscow MASHINOSTROITEL in Russian No 3, Mar 85 p 18

GAVRILOV, V.G., Engineer.

[Abstract] The gripper described has two conical surfaces which are deformed to increase the force acting on the product being lifted, preventing wedging or breaking of the lobes on the chuck. The device can automatically and reliably grasp, hold, displace and remove products used in automatic machining operations.

[289-6508]

UDC: 621.919.2./3

BROACHING OF LARGE DIAMETER GEARED DRUMS

Moscow MASHINOSTROITEL in Russian No 3, Mar 85 pp 23-24

KHOLMOGORTSEV, Yu.P., Candidate of Technical Sciences.

[Abstract] In order to improve the workability of thermally improved drums and increase the efficiency of gear manufacture at the Chelyabinsk tractor plant imeni V.I. Lenin, a single-press method of coordinated broaching of the teeth of a large gear drum on a special horizontal broaching machine model KU-375 with a force of 1500 kN was tested. Each row of broaches is

divided into three sections, each 490 mm in length, to avoid changing of dimensions during heat treatment. A special coordinating device is used to support the tool and maintain its strict alignment with respect to the motion vector over the entire length of the stroke. Tests have shown that the process decreases the deviation in spacing between teeth. The variation in tooth circle length is not over 0.3 mm, 0.2 mm in 85% of products. The new process places increased demands on the quality of cast iron drum blanks, however.
[289-6508]

UDC: 621.0.02.012.5:62-472 002.54

BORING TOOL FOR DEEP HOLES

Moscow MASHINOSTROITEL in Russian No 3, Mar 85 pp 25-26

SILIN, N.S., Engineer

[Abstract] A tool for drilling deep holes is described; it utilizes the principle of feeding the cutting fluid into the hole in a pulsating mode such that the fluid moves as in hydraulic shock. As a sleeve in the middle of the device rotates, it periodically closes and opens the passages through which the cutting fluid flows, creating the pulsating pressure of the fluid. The rotating speed and number of channels around the circumference of the device must be selected depending on the type of metal being cut, since these two factors determine the conditions of pulsation of the cutting fluid flowing through the device. Use of the device reduces the intensity of wear of the cutting tools.
[289-6508]

UDC: 531.714.7.08

DEVICE FOR TESTING MICROMETERS

Moscow MASHINOSTROITEL in Russian No 3, Mar 85 p 32

CHERTOUSOV, A.A. and SILITSKIY, N.V.

[Abstract] The device for testing the position of the contact surfaces of micrometers consists of a plane-parallel stage plus an autocollimation system. Micrometers to be tested are placed on the device to test whether the contact surfaces of the micrometer are parallel. If not, the light reflected from the two surfaces and collimated in the device will reveal the misalignment. Use of the device leads to better product quality and increases labor productivity.
[289-6508]

FASTENERS

Moscow MASHINOSTROITEL in Russian No 3, Mar 85 p 33

VELIKOIVAN, S.V., Candidate of Technical Sciences, and DOLYAR, Ya.N.

[Abstract] A flexible wire-core fastener is described. The device is particularly convenient for fastening together parts with small holes or with angled holes. The flexible core fastener can also be used to fasten together several parts with arbitrary orientation of fastening holes by separating the wires of the core and passing several wires through each of the holes. The fasteners are not sensitive to seating surfaces that are not parallel, allowing attachment of flanges with manufacturing errors.
[289-6508]

UDC: 621 865.8

BALANCED ARTICULATED MANIPULATORS

Moscow MASHINOSTROITEL in Russian No 3, Mar 85 pp 16-17

RYZHOV, I.N. and ARINICHEVA, L.Ye.

[Abstract] ShBM-150 balanced articulated manipulators developed by the All-Union Scientific Research Institute of Industrial Transport, have been introduced at the plant imeni V.M. Doyenin in Klimovo, performing hoisting and transport operations moving loads of up to 150 kg, primarily for loading and unloading metal cutting, forging and other equipment. The devices feature high precision of placement and a broad range of adjustment of movement speeds. The technical characteristics of the devices are presented in a table.
[289-6508]

UDC 531.716.3.088:621.833

MORE ACCURATE MEASUREMENT OF RADIAL WOBBLE OF GEAR CROWN

Moscow METROLOGIYA in Russian No 11, Nov 84 pp 21-25

GAFANOVICH, G.Ya. and MIKHAYLOVSKAYA, O.P.

[Abstract] The radial wobble of a gear crown, the most sensitive indicator of kinematic imprecision, is now measured with a gauge placed in each slot between teeth of the gear while the latter is rotated. The effect of tangential kinematic gear error can be eliminated and the measurement of radial wobble thus made more accurate by use of a conical or prismatic gauge with a

vertex angle equal to twice the pressure angle; a spherical gauge is less desirable but acceptable. With a conical or spherical gauge, however, there appears a new component of measurement error caused by friction at the centers of contact. An evaluation of this error based on analysis of all forces and moments involved in gauge insertion and gear rotation reveals that imprecise gear setting produces an error in measurement of radial wobble which is proportional to that wobble, with the sine of the pressure angle as the proportionality factor. In practical terms, for a 20° pressure angle, this amounts to a $0.1 \mu\text{m}$ error in measuring a $0.3 \mu\text{m}$ wobble. This is excessive for checking high-precision wobble gauges in the $1 \mu\text{m}$ class against reference gears certified to be in the $0.3 \mu\text{m}$ precision class. To minimize this error caused by the friction resulting from a difference between the forces acting on adjacent tooth profiles, it is proposed to split the gauging operation into two steps with a spherical setting gauge used first and a conical measuring gauge used afterward. The stem of the spherical gauge passes through an axial hole in the conical one so that, in the case of a small measuring force, there are sufficiently large restoring forces which ensure reliable positioning of the gear. Figures 2; references: 3 Russian.
[300-2415]

UDC 621.689.2

OPERATIONAL RELIABILITY LEVEL OF RECIPROCATING PUMPS

Minsk IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: ENERGETIKA in Russian No 6, Jun 85 (manuscript received 28 Dec 83) pp 110-114

BASHUROV, B.P., candidate of technical sciences, docent, Novorossiysk Higher Marine Engineering School

[Abstract] A reliability analysis of reciprocating pumps has been performed, for the purpose of planning preventive maintenance and standby availability in heat power and petrochemical industries where such pumps are widely used. Analysis by the method of rank correlation here, assuming an ordinary and stationary simple failure flux without aftereffect and with reciprocating pumps regarded as repairable items. This method was applied to electrically and steam driven pumps with $10\text{--}250 \text{ m}^3/\text{h}$ capacity and $0.8\text{--}8.5$ pressure head. The rank matrix was constructed for a lot of 32 samples and estimates by 23 experts. Into account was taken corrosion along with erosive wear and mechanical shock as the major causes of failure, with fretting corrosion particularly significant as a result of valve vibration combined with friction, and other components besides valves including seals and sleeves as well as piston and connecting rod. Field data and microstructural analysis of failed components confirm the conclusion of rank correlation analysis, namely that the failure flux in every case first increases to a peak within the first $0\text{--}4000$ hours of operation, then drops to a lower level at which it quasi-stabilizes within the next 4000 hours, and subsequently increases again toward a condition of instability attributable to the irreversible aging process within the last 4000 hours. The probability of failure-free

operation meanwhile decreases monotonically from 1.0 at time $t = 0$ to below 0.25 or even zero after 12,000 hours of operation. While the general trend is the same in each case, there are quantitative differences in terms of failure intensity and life depending on specific pump design and application. Composite reliability indicators have been obtained on the basis of this analysis for fuel pumps, drainage pumps, and scavenger pumps. Article was presented by Department of Shipboard Power Plants Operation. Figures 3; tables 1; references 5: 4 Russian, 1 Western [in Russian translation]. [307-2415]

UDC 621.9:621.869.9:621.318.3

VIBRATORY LOADING DEVICE WITH VIBRATION EXCITER AND ELASTIC SYSTEM DRIVEN BY TRANSVERSE-ACTION ELECTROMAGNETS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 4, Apr 85 (manuscript received 17 Jul 84) pp 94-98

VARYASH, G.M., candidate of technical sciences, LEBEDOVSKIY, M.S. [deceased], candidate of technical sciences, and MATKIN, Yu.L., candidate of technical sciences

[Abstract] The performance of a vibratory loading device with transverse-action electromagnetic exciter-drive is analyzed on the basis of a dynamic model of the mechanical analog with compression springs simulating the stiffness of the electromagnetically elastic system components and with equivalent viscous damping. The corresponding second-order nonhomogeneous differential equation of forced vibrations is formulated assuming a harmonic motion and then solved through reduction to a homogeneous one. The amplitude-frequency characteristic of this device has a resonance peak whose height decreases as the damping increases and whose width increases with increasing excitation force. The vibration amplitude depends also on the stiffness of the electromagnetic system components, according to the half-power dependence of the natural vibration frequency on that stiffness. Figures 3; references: 3 Russian. [271-2415]

METHOD OF INCREASING EFFICIENCY OF FLUIDIC AUTOMATIC BALANCER

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 4, Apr 85 (manuscript received 5 Jun 84) pp 35-38

NESTERENKO, V.P., candidate of technical sciences, docent, and SOKOLOV, A.P., graduate student

[Abstract] The inherently low efficiency of a Le Blanc fluidic automatic rotor balancer can be increased by partitioning it into many coaxial cylindrical compartments and filling each only partly with fluid. Such a balancer is mounted on an elastic vertical shaft underneath the rotor disk and rigidly joined to the latter. An analysis of the steady-state force balance in this system, assuming plane rotation without wobble, reveals that the shaft displacement relative to the axis of rotation is positive at speeds below critical and negative at speeds above critical. The balancer efficiency is defined as the ratio of coordinates x_d/x_{d+b} locating the center of mass of the rotor disk alone and the center of mass of the rotor disk + fluidic balancer system. For a multicompartmental balancer, unlike for a single-chamber one, this efficiency depends on the sum of the squares of the free-surface radii. Calculations based on typical dimensions of a fluidic balancer for a grinding wheel indicate that coaxial partitioning of the fluid chamber increases the efficiency severalfold. Figures 3; references: 2 Russian.
[271-2415]

PERFORMANCE OF CLUTCHES WITH QUASI-ZERO STIFFNESS UNDER TRANSIENT CONDITIONS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 4, Apr 85 (manuscript received 13 Jul 84) pp 19-23

ROGACHEVSKIY, V.M., Candidate of technical sciences, KIRKACH, N.F., candidate of technical sciences, professor, and YEVMENKIN, V.I., candidate of technical sciences, docent

[Abstract] An elastic clutch is considered in a torsional system where it connects a driving motor with small rotor mass to a driven large load mass, both motor and load being much stiffer than the two clutch jaws. An adequate model of this system for analysis of its vibrations and stability after a short shock or sudden application of an external moment is a pair of masses connected through a spring, with the driven clutch jaw assumed to remain stationary. The corresponding equation of motion is solved, upon expansions into a power series and a Maclaurin series with subsequent retention of principal terms only, assuming that all rotating members are mounted on ideal ball bearing. An analysis of the solution yields the

position of static equilibrium in which the restoring moment vanishes, also the critical magnitude of a perturbing moment and the critical speed. Figures 1; references: 3 Russian. [271-2415]

UDC 681.3.06

AUTOMATION OF PROGRAMMING

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 286, No 1, Jan 86
(manuscript received 25 Nov 85) pp 66-69

BETELIN, V.B., Science Council on Comprehensive Problem "Cybernetics",
USSR Academy of Sciences, Moscow

[Abstract] A new programming procedure is proposed which makes the automation of programming feasible. It is based on two premises removing the obstacles to automation of conventional programming procedures. Firstly, encoding, testing, and debugging are treated as parallel processes, inasmuch as these operations concur on each step of decomposition. Secondly, implementation of a program system requires fundamentally different hardware than its subsequent execution. The main deficiency of existing program systems including an interface with the programmer is that they do not include provisions for inverse transformation of machine representation of data into their original representation and that, therefore, arbitrary events occurring during program execution by the computer cannot be formally interpreted in terms of the original program. The need for this facility was ignored twenty years ago, when optimality of the program and not effectiveness of error diagnosis or economy of debugging time was the overriding criterion. The conventional procedure of encoding and decoding program texts is also inefficient, inasmuch as the results of decoding and analysis are usually discarded as being of no further use instead of being retained for any other translation of the original program. In the new procedure the process of constructing a program system can be conceptualized as a stepwise refinement, first of external specifications and then of internal specifications, under operational and peripheral constraints. Accordingly, the representation of a program system according to the proposed methodology reduces to a single one throughout its construction, correction (editing-compiling), and execution. The programming hardware constitutes here an integrated editing-compiling-executing system of the "Cornell synthesizer" kind. This system can operate in either of three modes: 1) editing the program; 2) editing the local and/or global data; 3) executing the program or its fragments with the possibility of roll-back. The methodology as well as the basic firmware and backup, developed at the Science-Industry Center of the USSR Academy of Sciences and at the Planning Department for problems of computer-aided design in machine design of the I.A. Likhachev Moscow Automobile Manufacturing Plant, have already been tested and approved. Article was presented by Academician Ye.P. Velikhov on 26 September 1985. References 11: 2 Russian, 9 Western (8 in Russian translation). [79-2415]

OPTIMUM DESIGN OF AXIORADIAL TURBINE STAGES

Minsk IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: ENERGETIKA in Russian No 3, Mar 85 (manuscript received 6 Sep 83) pp 118-121

KIRILLOV, I.I., doctor of technical sciences, professor, and LITINETSKIY, V.V., candidate of technical sciences, docent, "Order of Lenin" Leningrad Polytechnic Institute imeni M.I. Kalinin

[Abstract] The problem of optimizing the parameters of axioradial turbine stages along the mean streamline for minimum energy losses and thus maximum efficiency is formulated by adding the relation $G = \rho_2 c_{2z} F_2$ for the flow rate behind the runner (ρ_2 - density of steam, F_2 - area of channel exit cross-section, c_{2z} - flow coefficient) to the relation for the loss of velocity head $\gamma_v = 2(c_{1v}v_1 - c_{2v}v_2)/C_0$ (v_1, v_2 - absolute peripheral velocities, c_{1v}, c_{2v} - peripheral projections of absolute velocities, C_0 - constant, 1 - entrance to stage, 2 - exit from stage), and then expressing all velocities in terms of v_1/C_0 , reactivity σ_T , velocity coefficients ϕ, ψ , nozzle angle α_1 , and blade angle β_2 in dimensionless variables. This procedure eliminates the need for constraints on the exit velocity triangle and indeterminacy of the solution. The procedure has been applied to an isentropic flow. The efficiency is found to drop appreciably below its ideal maximum, because at low discharge rates the disk friction becomes more significant and at high discharge rates the radiality becomes more significant. These conclusions are confirmed by analysis and generalization of available experimental data on runners 25-660 cm in diameter with 7-29 blades 6-27.5 cm long and a 0.35-0.61 radiality. On this basis, axioradial counterflow stages for K-300 and K-800 steam turbines can be classified as low-discharge and medium-discharge ones, respectively, the discharge rate being near its optimum in each case and correspondingly so the efficiency. Article was presented by Department of Turbine Construction. Figures 3; references: 4 Russian.
[276-2415]

SELECTION OF OPTIMUM PRESSURE FOR DEAERATORS IN STEAM-TURBINE PLANTS

Minsk IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: ENERGETIKA in Russian No 6, Jun 85 (manuscript received 31 Jan 84) pp 67-71

SHELEPOV, I.G., candidate of technical sciences, docent, ARKADYEV, B.A., candidate of technical sciences, and NECHUYVITER, M.M., engineer, Ukrainian Polytechnic Correspondence Institute imeni I.Z. Sokolov; Planning Department, Kharkov Turbine Works imeni S.M. Kirov

[Abstract] With the introduction of sliding initial pressure in steam-turbine plants, for extending the range of load regulation without degrading the performance at the minimum cost of redesign, it becomes necessary to appropriately optimize the steam parameters in all plant components. For the feedwater deaerator, specifically, the optimum steam pressure p_d is selected on the basis of maximum absolute internal gross plant efficiency η_i as criterion, considering that the maximum efficiency corresponds to $\partial \eta_i / \partial p_d = 0$ and is $\eta_i^{\max}(p_d) =$

$$1 - \frac{(\partial \alpha_c / \partial p_d) q_c - \alpha_c (\partial q_c / \partial p_d)}{\partial q_0 / \partial p_d}$$

(q_0 - rate of heat flow per cycle, including heat for intermediate superheat, q_c - heat loss in condenser, α_c - rate of steam flow into condenser). Minimum underpowering and minimum steam flow into the condenser, both functions of the deaerator pressure p_d , require that $(\partial \alpha_c / \partial p_d) q_c = 0$. An analysis of these relations in accordance with the laws of thermodynamics and the heat balance reveals that they involve not only the specific volume of steam in the deaerator and the heat flow to the feedwater preheater but also on the enthalpy of steam in both feedwater preheater and condensate preheater as well as in the turbine. Five variants of optimizing the steam pressure in the deaerator at three typical load levels (full load and 75%, 55% nominal) are evaluated comparatively, assuming fixed parameters of both preheaters and either constant or sliding initial pressure in the turbine. Numerical data pertaining to a K-300-240 KhTGZ turbine set indicate that the optimum deaerator pressure does not depend much on the initial turbine pressure, whether constant or sliding, and that individual steam tapping to the deaerator is most economical while exclusion of the sixth high-pressure preheater stage without or with regenerative tapping of the deaerator is somewhat less heat efficient but much simpler. Article was presented by Department of Thermal Electric Power Plants. Figures 2; tables 1; references: 5 Russian. [307-2415]

COMPREHENSIVE SOLUTION TO PROBLEM OF DESIGNING POWER TURBINE STAGE FOR OPTIMUM PERFORMANCE CHARACTERISTICS

Kiev DOKLADY AKADEMII NAUK UKRAINSKOY SSR, SERIYA A: FIZIKO-MATEMATICHESKIYE I TEKHNICHESKIYE NAUKI in Russian No 5, May 85 (manuscript received 31 Aug 84) pp 75-79

SHUBENKO-SHUBIN, L.A., academician (UkSSR Academy of Sciences), DORFMAN, L.A., SERAZETDINOV, A.Z., STOYANOV, F.A. and BABAK, N.Yu., Institute of Problems in Machine Design, UkSSR Academy of Sciences, Kharkov

[Abstract] The problem of designing a power turbine stage is formulated mathematically for a comprehensive solution which will yield the maximum efficiency attainable under thermodynamic, mechanical, and reliability constraints. The problem is accordingly to find $\max_{c_1 \in W} \bar{\eta}(c_1)$ ($i = \overline{1, m}$), with $\bar{\eta}$ denoting the internal efficiency and the range W of design parameters defined by a system of inequalities characterizing given constraints on the stage geometry, on tensile and flexural stresses, on natural vibrations, on reactivity at the blade root, and on the channel taper respectively. The input data needed for solving this problem are runner speed, coordinates of blade root and blade tip (runner periphery) at entrance and exit sections, median diameter of the blade circle, thermodynamic properties of the entering gas stream and their profiles in the entrance section, mass flow rate through the exit section, density of the blade material, ranges of hazardous natural blade vibration frequencies $f_i + \Delta f_j$, maximum permissible reactivity at the blade root and minimum permissible taper of the channel width along the blade height, also maximum permissible tensile and flexural stresses. Solution of the problem requires successive construction of two models, a geometrical one of the turbine stage first and a comprehensive one of its operation next. The procedure is demonstrated on both root and tip contours, each describable by four corner points and a dimensionless Lagrange interpolation. For describing the operation, the blade surface is transformed from the system of two dimensionless coordinates into a system of three dimensional parametric coordinates. The comprehensive model combines three models: 1) "flow" model of the active medium in the stage channel, including conversion of energy into work; 2) mechanical "strength" model of a blade in state of stress and strain; 3) "vibration" model. Both geometrical and comprehensive models were used, the geometrical model with 86 design variables, for designing a maximum-efficiency turbine stage on a computer in the dialog mode. Calculations by this method required much less time than calculations by other known methods. Figures 1; references 8: 7 Russian, 1 Western (in Russian translation). [310-2415]

CONDITIONS AT DISCONTINUITIES ALONG EDGES OF BLADE ARRAYS DURING AXISYMMETRIC FLOW OF FLUID THROUGH CHANNELS OF TURBOMACHINES

Yerevan IZVESTIYA AKADEMII NAUK ARMYANSKOY SSR: MEKHANIKA in Russian Vol 38, No 1, Jan-Feb 85 (manuscript received 23 Jul 81) pp 39-46

KLIMOVICH, V.I. and FEDOROV, A.V., Institute of Engineering Physics imeni A.F. Ioffe, USSR Academy of Sciences

[Abstract] Large velocity gradients near the entrance to the rotating blade array in a turbomachine are, in the axisymmetric approximation, replaced with velocity jumps accompanied by energy jumps. The hydrodynamic conditions characterizing such jumps are then analyzed, assuming first an ideal working gas and small departures of the free stream from the planes tangential to the blades. The laws of mass, momentum, and enthalpy conservation in accordance with the second law of thermodynamics are expanded into six scalar equations, with an additional physically consistent constraint on the vector of the surface force. In the case of infinitesimally thin blades this system of equations can be closed by assuming that this force is orthogonal to the blade surface. An analysis of the characteristic determinant reveals that its vanishing corresponds to a gas with critical parameters and "stagnating" at the entrance section in the case of a zero transverse velocity or more generally to a tangential velocity coinciding with the local acoustic velocity. In the former case the problem reduces to oblique flow past a plane array of thin blades. The loss coefficient is calculated on this basis for compressible and incompressible fluids, multiplied by the impact attenuation factor to account for the thickness of real blades. For an incompressible fluid this factor must be determined experimentally. Figures 4; references 8: 7 Russian, 1 Western. [327-2415]

PRINCIPAL MECHANISM OF VIBROACOUSTIC EXCITATION IN VOLZHSKIY-AUTOMOBILE-PLANT ENGINES

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 4, Apr 85 (manuscript received 5 Nov 84) pp 72-75

NOSONOV, I.A., graduate student

[Abstract] A study of automobile noise was made, essential to a noise abatement program, specifically of noise of automobiles produced for export at the Volzhskiy plant. The study has revealed that the principal sources of external noise are engine, intake, exhaust, and rolling. Reduction of the acoustic power generated by the engine and the acoustic power associated with intake was sought, an improvement in this area being regarded as most effective and economical. A subsequent analysis of internal noise in the

engine by selective muffling of its various sources has revealed the gas distributor mechanism, the gas distributor drive, and the crank-and-rod mechanism as the principal ones. Accordingly, design changes in these components were tried experimentally with various degrees of success. Placement of shoes on the chain tightener and the chain damper was quite ineffective, with a noise reduction of 0.5 dBA only. More effective were replacement of the chain or the belt with a V-belt and hermetic encapsulation of the belt, resulting in a noise reduction by 1 dBA and 1.5 dBA respectively. Installation of an experimental crankshaft with narrower clearances in the main bearings as well as between journals and connecting rods, also with smaller extra counterweights, in a VAZ-2103 engine reduced the overall noise level by 2 dBA and thus most effectively. This indicates that the crank-and-rod mechanism contributes most significantly to overall engine noise, and not only in the low-frequency region of the spectrum. Figures 2; references: 3 Russian. [271-2415]

UDC 621.43.001

ACCOUNTING FOR HYDRODYNAMIC EFFECT IN DESIGN OF CRANKSHAFT

Moscow IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 4, Apr 85 (manuscript received 14 Jul 83) pp 59-63

NOVIKOV, V.I., candidate of technical sciences, docent, BUROV, A.L., candidate of technical sciences, docent, and BARSOV, A.B., engineer

[Abstract] In the design of a new diesel automobile engine with 8.75 dm³ displacement it was necessary to increase the diameter of crankshaft journals from 88 to 92 mm, with an attendant 1.4% (660 g) increase of total crankshaft mass, so as to raise the strength margin from near nil to approximately 15%. The effect this design change on the bearing hydrodynamics was evaluated for the main bearing on the basis of the Reynolds equation and by the method of finite elements, subdivision of the bearing sleeve into 816 elements ensuring very accurate results. The partial differential equation in hydrodynamic pressure and film thickness of the lubricant was solved by numerical evaluation of the variational functional satisfying this equation and having the form of a surface integral. The temperature dependence of the lubricant viscosity was accounted for according to the relation $\eta = 23.073(T/343)^{4.093.508/T}$ mN·s/m² for M10GFL oil and the mean temperature of the lubricant film was calculated from the equation of heat balance. Subsequent evaluation of the friction torque and then the friction power, as function of the shaft diameter, of the diametral bearing clearance, and of the minimum film thickness, revealed that the increase of friction power following an increase of the shaft diameter can be compensated by a corresponding increase of the bearing clearance. The latter should be made so wide as to maximize the minimum film thickness. Figures 3; references 5: 4 Russian, 1 Western (in Russian translation). [271-2415]

ESTIMATES OF ASYMPTOTIC EXPANSION OF SOLUTION TO CERTAIN GYROSCOPE PROBLEMS

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 283, No 2, Jul 85 (manuscript received 3 Apr 84) pp 329-332

KUZMINA, R.P., Moscow Institute of Power Engineering

[Abstract] The asymptotic expansion of the solution to a problem is estimated first for a regular system $\frac{dx}{dt} = F(x, t, \mu)$, $x(0, \mu) = x^0$ with N -dimensional vectors x, F and then for a singular system $\frac{dy}{dt} = F_1(x, t, \mu)$, $\mu \frac{dz}{dt} = F_2(x, t, \mu)$, $x(0, \mu) = x^0$ with N_1 -dimensional vectors $x = (y, z)$, y, F_1 and N_2 -dimensional vectors z, F_2 . In each case μ is a small parameter. In the latter case functions $x_1^{(k)}(t)$ and $x_2^{(k)}(\tau)$ are assumed to exist at time $t \geq 0$ and at time $\tau \geq 0$ respectively. Six constraints are imposed on the fundamental $W(t, s, \mu) = E_{N_2}$ of system $\mu \frac{dz}{dt} = B(t)z$ (E_{N_2} - $N_1 \times N_2$ -dimensional unit matrix) and elements of the matrix $B(t) = F_{2z}(x_1^{(0)}(t), t, 0)$ as well as on the eigenvalues of the matrix $B(0)$. The derivatives

$\frac{dz}{dt}, \frac{d^m x_1}{dt^m}(0)(t), \frac{\partial^m F_1}{\partial x_1^{m_1} \dots \partial x_N^{m_N} \partial t^{m_N} \partial \mu^{m_{N+2}}}(x, t, \mu)$ are assumed to exist also in

the regular case. An existence theorem is stated pertaining to the fundamental matrix $U(t, s)$ of the system $\frac{du}{dt} = A(t)u$, $U(s, s) = E$ when its norm is not larger than $Ce^{\alpha(t-s)}$ and not larger than $C(t-s)^{\omega} + C'$ respectively ($\alpha > 0, \omega \geq 0, 0 \leq s \leq t$). This theorem has already been proved by A.

Poincaré for the regular case with a holomorphic right-hand side and by A.N. Tikhonov for the singular case. Asymptotic expansion of the solution and its estimates on a finite time interval and on an infinite time interval have been obtained by A.N. Tikhonov and A.B. Vasilyeva respectively. On the basis of this theorem is now considered the system of equations $(J\dot{q})' - \frac{1}{2} \frac{\partial}{\partial q}(\dot{q}^* J \dot{q}) + (D+H)\dot{q} = 0$, $q(0) = q^0$, $\dot{q}(0) = \dot{q}^0$ describing the motion of a gyroscopic system under gyroscopic and dissipative forces. This system of equations is reduced first to one with singular perturbations and then to one with regular perturbations. Both methods yield identical asymptotic expansions, but the second method makes possible estimating over a longer time interval.

Article was presented by Academician A.Yu. Ishlinskiy on 21 March 1984.

References: 7 Russian.

[330-2415]

USE OF PROGRAMMABLE READ-ONLY MEMORIES IN STEP MOTOR CONTROL CIRCUITS

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 2, Mar-Apr 85
(manuscript received 1 Feb 84) pp 206-208

VNUKOV, P.V., ROMANOV, V. Yu., BARYSHNIKOV, V.N. and PANACHEV, F.I.,
Moscow State University

[Abstract] Control circuits are described for step motors of various types that consist of serial synchronous circuits based on PROMs and a parallel register based on D-flip-flops. The state of the circuit changes when a sync pulse is applied to the timing input of the flip-flops, with the new state depending upon the feedback signals stored in the register, and the control signals applied to the inputs of the PROM. A circuit employing 8-bit words is described that is based on a K155PE3-series microcircuit and that can be used in conjunction with 5-, 4-, or 3-phase step motors. The simple circuits described can be co-located with the power source close to the step motor, and the control inputs can be isolated galvanically by means of optron circuits. The circuits have been used successfully to control ShD-2AM, ShDR-711 and ShD-5D1 step motors operating at up to 20,000 steps per second. Figures 3, references: 5 Russian.
[326-6900]

UDC 681.365.011.5

SYSTEM OF NANOSECOND PULSE LOGIC MODULES

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 5, Sep-Oct 85 (manuscript received 25 Jul 84) pp 73-78

BASILADZE, S.G., SMIRNOV, A.N., STEPANOV, A.N. and RYBNIKOV, V.M., Moscow State University

[Abstract] A system of nanosecond pulse logic modules is described for use in high-speed event acquisition devices for experimentation in nuclear physics. The use of pulse sampling makes it possible to process combinations of input signals with a repetition period significantly smaller than the total decision delay in the pre-sampling device. The system provides a time resolution of 2-4 nsec at the full-width level of the curve of the time spread of the pulses from the detectors. The system employs KAMAK modules and incorporates electronic delay control channels and module channel connect-disconnect control channels. The crate highway implements the KOMFEKS (KS) protocol. The modules employ K500, K155, and K559-series integrated circuits; each channel has three or four paraphase outputs, which practically eliminates the need for a special pulse splitter. Figures 5; references 12: 8 Russian, 4 Western.
[6900/52]

UDC 535.232.65:621.383.52

PRECISION PHOTODETECTOR WITH FREQUENCY OUTPUT

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 5, Sep-Oct 85 (manuscript received 25 Jun 84) pp 153-155

MARTYNYUK, A.S. and SACHKOV, A.V., All-Union Scientific Research Institute for Physical-Technical and Radio Technical Measurements

[Abstract] A precision photodetector is described that incorporates a two-band photodiode current-to-voltage converter interfaced with a voltage-to-frequency converter. The photodetector drift in noise or minimized by using a photodiode as an ungrounded photocurrent generator, which

is connected to the differential inputs of operational amplifier in a negative feedback loop. A sensitive threshold of $2 \cdot 10^{-13}$ W is achieved for photo-current-to-voltage and voltage-to-frequency conversion. The conversion response is within 0.02% of linear, and the absolute radiation power measurement error at fixed frequencies is 3-5%. Figures 3; references: 7 Russian. [6900/52]

UDC 621.378.325

USE OF HIGH-CURRENT PHOTOELEMENTS TO CONTROL LASER PULSE SHAPE

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 5, Sep-Oct 85
(manuscript received 17 Sep 84) pp 155-157

NILOV, Ye.V. and RUSOV, V.A., State Optics Institute

[Abstract] The use of FEK-09 photoelements for controlling laser pulse shape is investigated. The optical and voltage-current characteristics of these elements are investigated experimentally. The pulse-driven photoelements are used to stabilize a neodymium-glass laser that produces a train of pulses during each optical pumping pulse. The use of the photoelements in the photoelectric feedback circuit used to control the laser pulse shape reduces the power fluctuations to a few percent before pulse repetition frequencies ranging from several kilohertz to 100 kHz. Figures 2; references: 8 Russian. [6900/52]

UDC 621.317.412

SYSTEM FOR MEASURING CHARACTERISTICS OF SUPERCONDUCTORS IN ALTERNATING MAGNETIC FIELDS

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 5, Sep-Oct 85
(manuscript received 6 Jul 84) pp 164-167

ERMOLOV, S.N. and MARCHENKO, V.A., Institute of Problems of Technology of Microelectronics and Super Pure Materials, USSR Academy of Sciences

[Abstract] A system is described for monitoring the energy losses in superconducting materials exposed to an alternating magnetic field. The system works by measuring the energy flux of the external magnetic field in the specimen and determining the losses per unit of surface area of the specimen per cycle of the alternating field. The system consists of a liquid-helium cryostat to hold the specimen, differential amplifiers, a phase inverter, an amplifier, a synchronous detector, a stroboscopic converter, a graph plotter, a dual-trace oscilloscope, a function generator, a power amplifier, a stabilized dc source, a digital voltmeter, a voltage

follower, and adjusting potentiometers. The device, which provides sensitivity of 10^{-9} W/cm²·Hz, can be used to investigate the critical current distribution over the cross-section of the specimen, as well as the overall electrical resistance in the normal state. Figures 3; references 12:

3 Russian, 9 Western.

[6900/52]

UDC 531.717.621.375.826

LASER-TYPE DISPLACEMENT METER WITH BUILT-IN MICROPROCESSOR

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 1, Jan 85
(manuscript received 22 Mar 84) pp 30-33

GREBENSHCHIKOV, A.V., ZOLOTOV, A.V., KIRYUKHIN, Yu.I., MOVSHEV, A.K. and
RUSAKOV, S.A.

[Abstract] Scientific research has been completed on development of a laser-type displacement meter with built-in microprocessor. Its operation is based on counting of interference fringes with addition of optical heterodyning, just as in the IPL-10M.52 first laser interferometer commercially produced in the Soviet Union and its IPL-30K expanded version. Optical heterodyning is effected by means of a single-frequency laser with solid-state acoustooptic modulator. Its principal components, in addition to a laser transducer with a laser interferometer, are a set of reflectors and an electronic microprocessor of interference signals. The laser transducer consists of a frequency-stabilized single-frequency He-Ne laser, a collimator, an interferometer, an additionally separating afocal tube, three mirrors, two photoreceivers, an acoustooptic modulator, two diaphragms, and two lenses. The interferometer consists of a light-splitting cube, two angle reflectors for the reference signal and the informative signal respectively, and a wedge pair which orients the reference light beam and the informative light beam relative to one another depending on the modulator diffraction angle. An additional module with a set of light splitters and a set of reflectors is provided for measuring angular displacements. The microprocessor is built with series K580 LSI on a single board. It consists of a central processor unit, a clock-pulse generator, a system controller, an interrupt controller, a 4 kbyte read-only memory, a 1 kbyte direct-access memory, an address busbar monitor, a data monitor, and a control monitor. This microprocessor is interfaced with a phase-to-code converter on the input side, to a display panel on the output side, also to an analog-to-digital converter with four temperature transducers and one pressure transducer, with four extra interfaces being available for hookup to peripheral equipment. The phase-to-code converter consists of an 8 MHz reference-frequency channel (clock-pulse generator, program-controlled phase shifter, frequency synchronizer) and an $8+f_D$ Doppler-correction channel (signal detector, frequency subtractor, 16-digit counter), both feeding through a buffer register followed by the interface LSI into the microprocessor with feedback to the frequency synchronizer and to the phase

shifter as well as through the latter to the frequency subtractor. The phase-to-code converter is connected to the interferometer output through a matched symmetric cable. Linear and angular displacements are computed according to applicable interferometer algorithms, with allowance for the temperature-dependence of the laser wavelength. The microprocessor not only processes displacement and velocity readings but also automatically corrects the laser wavelength, partly monitors its own operating conditions, monitors and eliminates mistakes, reduces the discreteness of readings to 1/16th by programmed shifting of the signal phase, improves the reliability of readings by averaging them, compensates the effect of instrument vibration on the readings by smoothing them, and interfaces the instrument with an external computer. Under conditions of measurement stabilized according to GOST 8.050-80, the laser instrument with built-in microprocessor measures linear displacements with an error not exceeding 0.17 $\mu\text{m/m}$ and angular displacements with an error not exceeding 2" when the temperature is measured accurately within 0.1°C. Figures 2; references 7: 4 Russian, 3 Western.
[253-2415]

UDC 535.311

ATTACHMENT TO IAB-451 SHADOW INSTRUMENT FOR IMPLEMENTATION OF KRANTZ-CHARDIN SCHEME

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 1, Jan 85
(manuscript received 4 Apr 84) pp 35-36

KAMALOV, I.A., SUKHORUKIKH, V.S., FOKEYEV, V.P., KHARITONOV, A.I. and SHAROV, Yu.L.

[Abstract] A special attachment to the IAB-451 shadow instrument for study of fast processes makes it possible to implement the Krantz-Chardin scheme with parallel light beams. The shadow instrument together with this RP-463 attachment includes four condenser lenses which feed two mutually orthogonal pairs of parallel-opposing light beams from four flash lamps into a reflecting prism, which projects all four beams in the same direction normal to all four incident beams onto the plane of an entrance diaphragm in the focal plane of the IAB-451 collimator. This collimator includes a diagonal mirror and a specular-meniscus objective. The entrance diaphragm has four rectangular windows, each for passing the light from its corresponding lamp to the diagonal mirror reflecting them onto the objective. Parallel light beams from this objective pass through the test object to another specular-meniscus objective, in whose focal plane there is located the visualizing IAB-451 diaphragm. Another prism separates the light beams and sends them each to another of four registers, in whose focal plane an image of the object is formed by this second specular-meniscus objective and four plain other objectives. The attachment also facilitates implementation of the 4-slit vector-color shadow method, which yields simultaneously both magnitude and direction of a light beam deflection from a single shadow pattern--after

the four rectangular windows in the entrance diaphragm have been replaced with four cruciform slits and four light filters (blue, green, yellow, red) placed behind each, correspondingly. The shadow instrument with this attachment was used for study of reflections of a shock wave propagating through nitrogen-filled channels of various shapes at Mach = 2.9 velocity, in the light from an ICP-1500 xenon flash lamp (approximately 1 μ s flash duration) 10 mm long and with a 1 mm capillary. Photographic sweep was obtained with an IFK-50 flash lamp (approximately 800 μ s flash duration). Figures 2; references 6: 5 Russian, 1 Western.
[253-2415]

UDC 535.24

USE OF PYROELECTRIC RECEIVER FOR RECORDING VACUUM-ULTRAVIOLET RADIATION PULSES

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 1, Jan 85
(manuscript received 13 Dec 83) pp 59-60

BAYUNOV, V.I. and PUKHOV, A.M.

[Abstract] Among pyroelectric receivers generally used for study of pulsating radiation sources over a range from gamma rays to radio waves there are those applicable to vacuum-ultraviolet radiation pulses. One such receiver consists of a transducer, a matching circuit, and a power supply--all inside a shielded housing. The transducer is conical, its height 21 mm and its base diameter 5 mm, made of a pyroceramic material with silver coats on upper and lower base surfaces serving as electrodes. It has a capacitance of 3 pF, an intrinsic time resolution of 10^{-8} s, and a thermal decay time of $2 \cdot 10^{-2}$ s. The matching circuit consists of a KP303Ye field-effect transistor input stage and a KT326B-KT306D 2-transistor negative-feedback amplifier with 0.99 gain and $3 \cdot 10^4$ Mohm input resistance, with both the field-effect transistor and input resistor inside a shield connected to the emitter-follower stage. The power supply consists of two 3336 cells. The receiver output is connected through a coaxial cable to an oscillograph inside a double shield, with the outer one tied to the receiver housing and the inner one tied to the common (battery minus terminal). The emissivity of the receiver is 0.95 over the 0.45-20 μ m range of radiation wavelengths. The receiver is nonselective within 10% in visible and ultraviolet light, according to tests with an "Impuls-5" brightness standard and a set of filters. After calibration against a black body, it has a sensitivity of 10^3 V/J, a dynamic range of 10^{-6} - $2 \cdot 10^{-3}$ J, and a 0-0.1 J linearity range. The receiver was also tested with vacuum-ultraviolet high-current pulse discharges, photoemission energy losses having been found not to exceed 1-2% in the 120-140 nm range of wavelengths and 5% in the range of wavelengths shorter than 100 nm. Figures 2; references 6: 5 Russian, 1 Western.
[253-2415]

PERIODIC OPTICAL FARADAY-EFFECT CHOPPER

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 1, Jan 85
(manuscript received 26 Apr 84) pp 17-19

GAVRILOV, N.I., CODES, A.M., KRUPKIN, V.Kh., LEVIT, A.L. and
OVCHINNIKOV, V.M.

[Abstract] The design of an optical chopper on the basis of Faraday-effect rotation is outlined, a chopper for controlling radiation at the $1.06 \mu\text{m}$ wavelength in the periodic mode with repetition rates up to 100 Hz. The chopper includes a Faraday rotator, an air-core solenoid which produces a magnetic induction of 0.5-1 T for 45° rotation of the polarization plane, and a 3.6 nF capacitor bank which discharges into the solenoid in pulses. The capacitor bank is energized from a 220/800 V - 50 Hz transformer through a diode-rectifier bridge. The rotation angle is proportional to the square root of the capacitor discharge energy and inversely proportional to the square root of the solenoid radius, but does not depend on the number of solenoid turns, with a constant coefficient equal to the magnetic permeability of the medium multiplied by the Verdet constant and with a variable coefficient which depends on the ratio of solenoid radius to solenoid length and the ratio of rotator rod length to solenoid length. The rotation angle ϕ , normalized to $\mu_a V N l$ (μ_a - absolute magnetic permeability of the medium, Nl - solenoid ampere-turns, V - Verdet constant), increases from zero to unity as the relative length of the rotator rod increases, reaching unity at a smaller relative rod length as the relative solenoid radius decreases. The relative radial nonuniformity of the rotation angle, referred to the rotation angle at the solenoid axis, also depends on those two ratios: increasing monotonically as the relative solenoid radius increases but increasing with a sharp peak and then decreasing to zero as the relative rotator rod length increases beyond the solenoid length. Calculations based on the applicable relations for a Faraday rotator require evaluation of three elliptic integrals, respectively, of the first, second, and third kinds, for which computer programs are available. An optical chopper has been designed according to this procedure with a rod made of MOS-13 glass 60 mm long and 8 mm in diameter, a solenoid 60 mm long and 17 mm in diameter with 60 turns of copper wire 1 mm in diameter, with the Verdet constant $V = 9.32 \text{ rad}/(\text{T}\cdot\text{m})$, and with a choke coil for resonance discharge of the capacitor bank. Figures 4; references 7: 5 Russian, 2 Western.
[253-2415]

WIDE-ANGLE EYEPIECES WITH REAL FOCAL PLANE IN FRONT

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 1, Jan 85
(manuscript received 16 Feb 84) pp 22-26

GONCHARENKO, Ye.N. and REPINSKIY, G.N.

[Abstract] Sixteen different multilens configurations for a wide-angle eyepiece with a real focal plane in front are evaluated with respect to design and performance characteristics. They include one simplest version of 4 lenses forming 2 components, one 2/5 version, one 3/3 version, two 3/4 versions, one 3/5 version, three 4/5 versions, four 4/6 versions, and three most complex 4/7 versions. The field of vision ranges from 30.00° (3/3, 3/4, 3/5 eyepieces) to 51.65° (4/7 eyepiece) and double those angles for a pair of eyepieces; the total length of eyepiece from front surface of first lens to back surface of last lens, normalized to the focal length, ranges from 0.63 (3/3 eyepiece) to 2.39 (4/7 eyepiece). Two of the eyepieces (2/4 and 2/5) contain lenses with flat and parabolic surfaces; all of the others contain lenses with flat and spherical surfaces. The image can be constructed according to four patterns: orthoscopic, sinusoidal, arcuate and flattened. On the basis of overall design and performance indicators, the three 4/5 eyepieces are recommended as the best ones. They contain lenses made of only two grades of optical glass, STK19 and STF11, which simplifies the eyepiece technology. Their paraxial focal length is $f_0' = 25.5-26.4$ m, relative distance of exit pupil is $Z_p' = 0.64-0.71$, angle of vision in the image space is $\omega' = 45.23-45.31^\circ$, index $K = \frac{1}{2} \omega' Z_p' / f_0' = 0.508-0.556$, and magnification chromaticity ranges from -0.01 to $+0.01$, aberrations being corrected better than in the other eyepieces. Arcuate or flattened image construction are necessary for minimizing the additional astigmatism caused by overfocusing as well as other shape distortions of small or large objects. Figures 2; tables 4; references 22: 19 Russian, 3 Western.

[253-2415]

UDC 535.375+621.372

MULTIMODE FIBER-OPTIC RAMAN CONVERTER OF LASER RADIATION

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 1, Jan 85
(manuscript received 20 Mar 84) pp 28-30

NESTEROVA, Z.V., ALEKSANDROV, I.V., MEDVEDEV, A.A., POLNITSKIY, A.A. and SOLOVYEV, V.V.

[Abstract] The feasibility of laser tuning by a mechanism of stimulated scattering in multimode optical fibers is examined on the basis of theoretical estimates and experimental data. Optical fibers offer a more practical

alternative to cubically nonlinear crystals, because of the much longer interaction space and thus much lower thresholds for pumping power. In the quartz core of a 100 m long optical fiber for tuning a YAG:Nd³⁺ laser, picosecond pumping pulses have stimulated Raman scattering by acoustic phonons with up to 24 steady-state Stokes components over the 532-1170 nm range of radiation wavelengths with simultaneous excitation of anti-Stokes components, while nanosecond pumping pulses at a 12.5 kHz repetition rate have stimulated Mandelstam-Brillouin scattering by acoustic phonons. The efficiency of pump energy to scattering energy conversion reached 80% in the first case and 65% in the second case, with a radiation power per pulse up to 50 kW and 10 kW, respectively. Figures 2; tables 1; references 9: 8 Russian, 1 Western.
[253-2415]

UDC 681.7:621.384

ACCOUNTING FOR ANTISOCHRONISM OF INPUT OPTICS OF PHOTOCHRONOGRAPH DURING RECORDING OF SUBPICOSECOND LASER PULSES

Moscow IZMERITELNAYA TEKHNIKA in Russian No 5, May 85 pp 32-34

KOLESOV, G.V., KORZHENEVICH, I.M., LEBEDEV, V.B. and STEPANOV, B.M.

[Abstract] Photochronographic recording of subpicosecond radiation pulses from a laser with a stable resonator but also with a caustic-containing surface is considered; distortions become appreciable here as a result of aberrations caused by dispersion of the refractive index and as a result of anisochronism at the photocathode. Anisochronism, manifested as pulse pulling, distorts the pulse form during a circular or spiral scan and bends the image of the timing slit during a linear scan. The mechanism of distortions resulting from anisochronism is analyzed as a problem of geometrical optics, on the basis of a hyperboloidal single-lobe caustic surface and spheroidal wavefronts in a cylindrical system of coordinates. Construction of an image on the photocathode is treated in accordance with Fermat's principle, whereupon the distortions and resulting errors are evaluated for each scanning mode. The general conclusions are applied specifically to the Agat photochronograph operating with a linear scan. The effect of anisochronism can be reduced by regulation of the photocathode illuminance, by mutual compensation of anisochronism in the input optics and in the optoelectronics, time lag against time lead, or by omission of the input objective, or by optimizing the distance between second and third objectives after anisochronism in the optoelectronics has been eliminated by redesign. Figures 2; references 9: 8 Russian, 1 Western.
[303-2415]

THERMAL STRAINS IN LASER CELL CAUSED BY SELF-HEATING

Moscow METROLOGIYA in Russian No 11, Nov 84 pp 25-34

BELOZERTSEV, A.N., ISAYEV, A.I. and NOVIKOV, N.I.

[Abstract] A major problem in the use of He-Ne lasers for measurements, with the light beam serving as an etalon of rectilinearity, is the instability of the radiation parameters in time and particularly the attendant instability of the laser beam axis in space. A principal cause of instability is heating, and a shorter heating period should improve the laser stability characteristics. Another way to minimize instability is to optimize the structural design. This is demonstrated by an analysis of thermal strains in the discharge tube. The one-dimensional beam equation $EI_x = d^2y/dx^2 - M$ is formulated and solved for a hollow circular cylinder supported on two bearings and carrying three loads. The discharge tube containing the gas mixture constitutes a combined mechanical and thermal load uniformly distributed over approximately the middle two-thirds of the span between bearings; the mechanical load is the consequence of weight and the thermal load a consequence of uniform heating, which causes longitudinal expansion while non-uniform cooling causes transverse deflection. The other two loads are Brewster mirrors, one mounted at the end of each beam extension. The general solution to this equation indicates the optimum positioning of the resonator axis in the tube, typically fastened at the center. Numerical design data have been obtained on this basis for the LGN-202 laser. Figures 2; references: 6 Russian. [300-2415]

ADDITIONAL ERROR OF DIGITAL ANGLE TRANSDUCERS CAUSED BY EXTERNAL EFFECTS DURING OPERATION

Moscow METROLOGIYA in Russian No 11, Nov 84 pp 3-7

DOMRACHEV, V.G., KOTOV, Yu.T., MEYKO, B.S. and SIRYACHENKO, N.A.

[Abstract] During operation of digital angle transducers, there appear additional errors caused by slowly varying external effects and by fast varying external effects. While the former gradually change the amplitude as well as the rise time and the fall time of logic pulse signals, the latter cause harmonic fluctuations of both rise and fall times so that it becomes impossible to unambiguously determine the time interval within which code digits switch at the decoding level. The indeterminacy zones of code reading can cover angles comparable with the quantum angle, but inhibition of these zones will reduce transducer accuracy. In order to estimate this inevitable additional error and attainable transducer accuracy, it is

necessary to determine the probability distribution of the error over a given interval in both integral and differential forms. This is done here for logic "1". The quantitative results of the probability and accuracy analysis are taken from experimental data on electromagnetic transducers with either linear or nonlinear readout which have been subjected to vibration as well as to interference by a sinusoidal parasitic current in the supply circuit or by a sinusoidal electromagnetic field. Figures 2; references: 3 Russian.
[300-2415]

UDC 681.7.055.3

HOLOGRAPHIC INSPECTION OF ANAMORPHOTIC OPTICS

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 3, Mar 85
(manuscript received 15 Aug 84) pp 45-47

LUKIN, A.V., MUSTAFIN, K.S., RAFIKOV, R.A. and TOPORKOVA, I.A.

[Abstract] Three holographic methods of inspecting aspherical surfaces in anamorphic optics other than cylindrical ones are outlined, particularly suitable for toroidal surfaces. With a reference toroidal surface available, inspection with a Twyman-Green interferometer proceeds as usually. With a reference toroidal surface not available, two spherical surfaces with radii respectively equal to the meridional radius and the sagittal radius of the toroidal object are required. The hologram is in this case generated by double exposure with successively each sphere and only then the toroidal object placed in the "test" arm of the interferometer. The interference pattern behind the hologram appears in the form of two mutually orthogonal arrays of fringes. The need for two spherical reference surfaces has been eliminated by introduction of an axial hologrammic lens. Now a hologram of a point source is generated with a focal length $f = \frac{1}{2}(R_m - R_s)$ and placed at a distance $r = \frac{1}{2}(R_m + R_s)$ from the concave toroidal surface (R_m, R_s - respectively meridional and sagittal radii of curvature of the toroidal surface), whereupon it is illuminated with a plane wave so that in the two "+" and "-" first diffraction orders there will appear two spherical waves with surface radii respectively equal to R_m and R_s at a distance r from the hologram. Inspection with a Twyman-Green interferometer can then proceed according to the autocollimation scheme. Figures 3; references: 8 Russian.
[288-2415]

CAS-DISCHARGE SOURCE OF MICROSECOND RADIATION PULSES

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 3, Mar 85
(manuscript received 22 Jun 84) pp 47-49

DASHUK, P.N., KOVTUN, A.V., LUKASHENKO, S.V. and MARTYROSOV, V.A.

[Abstract] A gas-discharge light source has been developed which emits radiation pulses of 5 μ s duration, with emphasis on high yield in the ultra-violet region of the spectrum. Its essential component is a bank of two IK-50-3 capacitors acting as both energy storage of 5 kJ capacity and current-pulse generator, a gas-discharge tube connected to each capacitor through a common gas-filled discharger. This discharger with a self-inductance of 20 nH, rated for 40 kV - 30 kA, acts also as commutator and is triggered by an intermediate electrode which with a 70 kV voltage pulse distorts the electric field between the two main electrodes. The self-breakdown voltage in this discharger can be controlled over the 5-40 kV range by regulation of gas pressure and interelectrode distance. The lamp includes a metal bulb, 9 dm³ large and 750 mm long, containing the gas mixture and two discharge tubes. With discharge tubes having an inside diameter of 10 mm and a wall thickness of 2 mm, the lamp can generate at least 1000 flashes of 5.2 μ s duration and 200 J energy in the 200-380 nm region of the spectrum, under a gas pressure of 20-25 torr and with flashes from both tubes not more than 0.1 μ s out of synchronism. The efficiency of this lamp is 7.3% and its integral luminosity is 0.2 J/cm². The 10 mm tubes can be replaced with 18 mm tubes having the same 2 mm wall thickness. Figures 1; references: 2 Russian.
[288-2415]

UDC 621.383.8

INSTRUMENT FOR INTEGRAL ESTIMATION OF IMAGE QUALITY IN OPTOELECTRONIC VISUAL-AID DEVICES OPERATING UNDER LOW ILLUMINATION LEVELS

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 3, Mar 85
(manuscript received 10 May 84) p 59

MATSKOVSKAYA, Yu.Z., SAVENCHUK, N.A. and EDELSHTEYN, Yu.G.

[Abstract] An instrument has been developed for direct measurement of the generalized parameter $P(N)$, the objectively measurable equivalent of the signal-to-noise ratio subjectively perceived by an eye and equal to the product of the signal-to-noise ratio within one pattern unit of a test object (black and white dashes) by the contrast transmission coefficient $T(N)$. The instrument consists of a low-intensity lamp, optics for forming an image of the test object, and an optical receiver. The receiver includes a microobjective, an image rotator with a Poehan prism, a movable analyzer-diaphragm, a photomultiplier, and a microscope for visual adjustments. The

image of a test dash is superposed on the slit in the diaphragm by rotation of the prism and linear movement of the microobjective; the latter is driven by a stepper motor which is computer-controlled and programmed according to Newton's interpolation formula. The signal and noise within the eye's frequency range are measured, while a black dash and a white dash of the test object are successively passed across the slit. The photomultiplier output signal is recorded for determination of its mean value and root-mean-square deviation (noise). Figures 1; references 5: 3 Russian, 2 Western (1 in Russian translation).
[288-2415]

UDC 535.818(088.8)

UNIVERSAL INSTRUMENT FOR MONITORING OPTICAL PARAMETERS OF PHOTOGRAPHIC AND MOTION PICTURE CAMERAS

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 3, Mar 85
(manuscript received 16 Feb 84) pp 26-29

SANNIKOV, P.A., GORDEYCHIK, V.T. and ELIZAROVICH, Yu.L.

[Abstract] A multipurpose instrument PKU-3M for monitoring the optical performance parameters of motion picture cameras as well as of still photographic ones is now available and being pilot-tested in several enterprises of the camera industry for corrections and adjustments. It can monitor the focusing of any camera, the location of the view finding plane in a reflex camera, the matching of viewing and shooting channels in a reflex camera, the distance scale, and the resolution at the center of the frame. It can also monitor the frame unsteadiness in a motion picture camera, which the previous model PKU-3 instrument could not do. Its main characteristics are focal lengths of $f_1 = 122 \pm 1\%$ mm and $f_2 = 400 \pm 1\%$ mm of the objective, a range of distances which can be simulated by sliding the objective: from 0.32 m to infinity with a basic error not exceeding 1%, a basic allowable defocusing error of $\pm(0.01-0.05)$, a range of measurable defocusing in objectives with focal lengths of 6.5-80 mm: $\pm(0.1-0.5)$ mm, and a basic allowable error of frame unsteadiness measurement of ± 0.005 mm maximum. The performance characteristics of this instrument conform to a linear dependence of its sensitivity on the product of stop number and focal length of the inspected camera, with the diffraction effect disregarded. The instrument comes with a set of test objects for calibration. It generally compares favorably with the German "Brennweiten-Messgerät" and "Moller-Kameraprufergert III" (models 28S, 28V, 45S, 45V) instruments. Figures 4; tables 1; references 12: 7 Russian, 3 East German, 2 Western.
[288-2415]

ZERO-ANGLE INDICATOR BASED ON INTERFEROMETER WITH REVERSE-CIRCUITAL TRAVEL OF RAYS

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 3, Mar 85
(manuscript received 22 Jun 84) pp 30-31

GERSHUN, M.A., KOTYLEV, V.N. and SEREGIN, A.G.

[Abstract] A zero-angle indicator for precise determination of angular coordinates and measurement of small angular displacements is described which utilizes interference with reverse circuital travel of light rays and oscillation of a mirror. Such an interferometer, which includes an equihedral prism coated with a light-slitting film on one face (base) and reflective films on the other two, offers technological advantages over a Michelson interferometer with a light-splitting Kester prism, inasmuch as it does not require precise positioning and offsetting of two right-angle half-prisms while they are bonded together. The other components of this interferometer, besides the prism and the mirror, are a monochromatic light source, a first objective, a circular diaphragm with alternate two reflecting and two transmitting quadrants, inclined at 45° to the light path, a second objective passing transmitted light to the prism, and a third objective passing reflected light to a photodetector. The prism refracts and then internally reflects the incoming light so as to reverse its path, one part of the light through both second and third objective to the photodetector and another part to the oscillating mirror at which interference occurs. As the mirror tilts through an angle α , the interfering light rays rotate through an angle 2α . The indicator operates on the basis of path-difference modulation. Electric signals are recorded with alternating current with a frequency equal to the mirror oscillation frequency by the method of synchronous detection.

Figures 2; references 6: 5 Russian, 1 Western.

[288-2415]

UDC 669.861.535.346

METAL-DIELECTRIC ABSORPTIVE OPTICAL COATINGS

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 3, Mar 85
(manuscript received 10 Jan 84) pp 38-41

LEVITINA, E.I., TATARINOVA, T.S., CHEKMAREV, V.M. and CHERNEVSKAYA, E.G.

[Abstract] Two metal-dielectric composite thin-film coating materials with high optical absorptivity have been developed for the instrument industry as well as some consumer products, to be deposited in the form of templets or reticles on glass or crystals such as quartz. They are $\text{Al}+\text{MgF}_2$ and $\text{Cr}+\text{SiO}_2$, each produced by simultaneous vacuum deposition from the vapor phase of both components, following evaporation of compact pellets into which

mixtures of the respective two fine powders have been pressed. Reducing the reflection coefficient in the 0.6-2.5 μm region of the spectrum to below 18% is feasible with a sufficiently high metal content, up to 50 wt.% or above; a further decrease of the reflection coefficient requires deposition of transparent interference coatings. While the $\text{Al}+\text{MgF}_2$ coatings have high mechanical strength and chemical resistance under normal atmospheric conditions at temperatures up to 150°C, the $\text{Cr}+\text{SiO}_2$ coatings preferably with additives for better binding combine heat resistance to much higher temperatures with high chemical resistance in humid air or aggressive (acidic as well as alkaline) media. Typical applications are instrument and watch dials, fine-division scales, test patterns, attenuator gratings, etc. Figures 4; references: 9 Russian. [288-2415]

UDC 535.317

VARIANT OF OBJECTIVE WITH EXTERNAL ENTRANCE PUPIL

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 3, Mar 85 (manuscript received 21 May 84) pp 22-24

TARABUKIN, V.V. and PONOMAREVA, M.N.

[Abstract] An objective with an external entrance pupil is described which corrects third-order aberration. It consists of a lens of finite thickness and a thin element. Its performance is analyzed by the method of separation of variables, which is applicable to any optical system with finite-thickness components. In this case the system is replaced with an equivalent system of three infinitesimally thin elements and two air gaps. The calculations are made according to geometrical optics in the approximation of a zero-width second air gap and a zero-angle paraxial ray, with the Petzval scale condition satisfied. Numerical design data have been obtained for an objective with second focal length $f'=100$, magnification 1:3.5, field of vision $2\omega = 40^\circ$, and distance to external pupil $x = -20$, using combinations of glass grades TK16-TK2-TF2, or TK16-K19-TF2, or TK16-BF7-TF4. Two of the four Seidel coefficients are found to be $S_{III} = 0.04$ and $S_{IV} = 0.25$, with the corresponding aberration-correction curves in the meridional and sagittal sections shown for three variants: 1) $S_I = 1$, $S_{II} = 0.1$; 2) $S_I = 1$, $S_{II} = -0.1$; 3) $S_I = 1$, $S_{II} = 0$. Figures 3; tables 4; references: 3 Russian. [288-2415]

APOCHROMATIC OPTICS OF 15X60 BINOCULAR WITH INTERNAL FOCUSING IN OBJECTIVES

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 3, Mar 85
(manuscript received 16 Apr 84) pp 20-22

INYUSHIN, A.I., KALYANOV, Yu.A. and NEFEDOV, B.L.

[Abstract] An apochromatic optical system for a 15x60 binocular has been experimentally developed which, while externally resembling the earlier 1969 version, has several new features. These include protective plane-parallel glass plates placed in front of the two objectives and separation of the third lens in each objective from the preceding lens pair by a sufficiently wide air gap which allows axial movement of that third lens for internal focusing over the +24-(-15) dioptres range. The plane of the intermediate real image in a zero-dioptres setting is sufficiently far removed from both first and second lenses in each ocular so as to prevent the inner surfaces of this lens pair from appearing in the field of vision, even in that of an eye with an ametropia as large as ± 10 dioptres. The minimum distance between an observer with normal vision and the object should be 9.4 m. A major advantage of this system is the almost identical magnification in both ocular tubes, even in the case of anisometropia of the observer's eyes, inasmuch as the optical power of the fixed lens pair is much lower than that of the movable third lens. Making the positive first and second lenses of fluorite ($n_D = 1.43383$, $\nu_D = 95.2$) and the negative third lens of TK23 glass ($n_D = 1.5891$, $\nu_D = 61.23$) corrects the secondary spectrum and thus effectively suppresses spherochromatic aberration as long as spherical aberration is small. An inherent drawback of this system is that a reticle placed in one ocular will not appear sufficiently sharp to an ametropic eye when the objective is internally focused on a very far or very near object. Figures 2; tables 2; references 3: 2 Russian, 1 Western.
[288-2415]

UDC 535.345.6

SYNTHESIS OF INTERFERENCE-TYPE OPTICAL COATINGS

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 58, No 3, Mar 85 (manuscript received 30 Aug 83) pp 676-680

STOLOV, Ye.G.

[Abstract] The author has proposed a method of synthesizing interference-type optical coatings to specified spectral characteristics which is based on solution of nonlinear equations with intricately superposed functions of the unknown variables. The solution to such an equation in $2m$ unknowns is sought on a $2m$ -dimensional grid and reduces to determining the number which corresponds to a point within the interval of variation in that $2m$ -dimensional

space. The basic algorithm, programmed for a computer with a memory which stores values of the superpositions, can be accelerated by means of a grid for F as the function of superpositions rather than as function all variables so as to reduce the dimensionality, utilization of values superpositions already stored in the computer memory, and subsequent linear interpolation. The algorithm must be adjusted for every specific problem so as to reduce it to the minimum number of operations every time. While the principle of this method is best demonstrated on a 3-layer sandwich coating required to have a transmission coefficient T at the wavelength λ , its speed does not depend on the number of layers. By this method a YeS-1040 computer can calculate coatings at the rate of 2000 variants per second for any number of layers. By the conventional method, meanwhile, a YeS-1040 computer can calculate only 90 variants per second for a 5-layer coating and the speed drops fast as the number of layers increases. References 7: 6 Russian, 1 Western.
[308-2415]

UDC 535.345.6:535.417

ANALYTICAL DETERMINATION OF DEPENDENCE OF OPTICAL CHARACTERISTICS OF NARROW-BAND FILTERS ON INCIDENCE ANGLE

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 58, No 3, Mar 85
(manuscript received 2 Nov 83) pp 681-684

OVCHARENKO, A.P.

[Abstract] Analytical expressions are derived for synthesis of optical filters with symmetric multilayer interference coatings, sufficiently simple so as not to require a computer, of special concern being the dependence of their optical characteristics on the incidence angle. Filters transmitting a spectrum of a width close to a single wavelength only and incidence angles ranging from 0 to 45° only are considered here, assuming the same ambient air on both sides. The interference matrix is constructed separately, because it is different, for a filter mirror with an odd number of layers on each side and an even number of layers on each side. In each case the layers, alternately strongly refracting and weakly refracting ones, are of quarter-wavelength thickness in normally incident light. The elements of the matrix in each case yield, with sufficient accuracy, the half-widths of both s-component and p-component transmission bands defined by values $T=1$ and $T=0.5$ of the transmission coefficient as well as the locations of these bands in the spectrum. The effect of departures from the nominal thickness of layers and from the nominal refractive index of materials on the optical characteristics in obliquely incident light is evaluated first analytically in most general terms covering any combination of layers in a filter of any order and then numerically for several combinations of layers (weakly refracting layers with refractive index $n_{\text{low}} = 1.32$, strongly refracting layers with refractive index $n_{\text{high}} = 1.76, 2.2$, or 2.7) in a first-order filter. The results reveal that variances of the layer thickness or of the refractive index can split the transmission bands, the separation

depending on the incidence angle. The separation can be minimized and the split even altogether eliminated, however, by adjustment of the width of the center gap in the filter structure. The author thanks I.N. Shklyarevskiy for interest and comments. Figures 2; references 8: 6 Russian, 2 Western (1 in Russian translation).
[308-2415]

UDC 535.8

TRANSFER FUNCTION OF OPTICAL SYSTEM WITH CORNER REFLECTOR

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 58, No 3, Mar 85 (manuscript received 16 Jan 84) pp 670-675

KORNEYEV, V.I.

[Abstract] A corner reflector in the form of a tetrahedron operating in the mode of total internal reflection is used in optical radar as well as in various autocollimators. Both the frequency-contrast characteristic and the modulation transfer coefficient of an optical system which includes such a corner reflector are calculated, taking into account not only the departure of the energy distribution in the Fraunhofer diffraction pattern from the classical one in the Airy diffraction pattern but also the effect of polarization aberration. Operation of a corner reflector involves splitting the incident light wavefront into six 60° sectors by the edges of the dihedral angles and their images in the corresponding opposite faces. Polarizational aberration is caused here by changes of polarization upon reflection by glass-air interfaces and the resulting split of the incident light wave into six elementary waves all out of phase with one another, these phase shifts being equivalent to wave distortions. The image luminance distribution can be expressed as the algebraic sum $I(x',y') = I_s(x',y') + I_p(x',y')$, such a linear combination of contributions by both s- and p-components being predicated on the fact that waves polarized in mutually orthogonal planes do not interact with one another. Numerical calculations for various space frequencies of a periodic grating as test object indicate that a corner reflector with metallized reflecting faces performs almost as well as an ideal plane mirror. Figures 4; references 12: 7 Russian, 5 Western.
[308-2415]

SYSTEM FOR GENERATING AND PROCESSING COMPLEX SIGNALS

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 2, Mar-Apr 84
(manuscript received 30 Apr 84) pp 227-228

YEGORENKO, Yu.F., KASHEVSKIY, V.V., MARKOVICH, I.I., SEMENYAK, P.L.,
SKAKUNOV, A.V. and TSRASOLOV, Yu.N.

[Abstract] A system is described for recording signals, changing the time scale, synthesizing signals with arbitrary form, and computing the auto-correlation and cross-correlation functions of the signals and their envelopes. The system consists of a signal recording unit and a correlator unit. The correlator computes the correlation integral and its envelope in digital form. The technical specifications of the system are presented. Figures 1.
[326-6900]

UNIVERSAL KAMAK STANDARD DIGITAL-ANALOG CONVERTER

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 2, Mar-Apr 85
(manuscript received 23 Apr 84) p 227

PIKHUN, V.N. and USTINOV, A.G.

[Abstract] A universal KAMAK-standard digital-analog converter is described that converts parallel binary code to proportional voltage. The device consists of 10 independent ten-bit digital-analog converters, and employs a set of 26 instructions. The device is based on K155, K140, K142, and K572 microcircuits and is built as a 1M module. The converter provides an output signal amplitude range of -10.24-+10.24 V, with conversion time of less than 5 μ sec. Figures 1.
[326-6900]

ELECTROOPTICAL PHOTOGRAPHIC DEVICE

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 2, Mar-Apr 85
(manuscript received 12 Jan 84) pp 222-225

STAROVOYTOV, A.T. and SNETKOV, Ye.I.

[Abstract] The EOFU-181 electrooptical photographic device, which provides single and periodically repeating "write-read-erase" cycles is described.

The EOFU-181 consists of three functionally connected blocks: A PROM-type EOFU-181BM space-time modulator, an EOFU-181 stored-program photographic cycle control device, and an EOFU-181BP modulator pulse power supply. The device permits an image to be written repeatedly in near-real time in the same frame, with 10^5 cm²/J sensitivity and resolution of 40 mm⁻¹. The device is intended for use in coherent optical and optical-digital processes for inputting dynamic optical images, and also as computer-synthesized space-time filters. The device provides a 2x1.8 cm² frame, maximum visualized image density of 2, and unlimited write cycles in the same frame with no degradation. Figures 1, references 5: 1 Russian, 4 Western.
[326-6900]

UDC 621.372.413-434.1:621.384.634

METHODS FOR INCREASING VOLTAGE IN TUNABLE ACCELERATING RESONATORS

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 2, Mar-Apr 84
(manuscript received 19 Nov 83) pp 29-31

AVERBUKH, I.I., and KARLINER, M.M., Institute of Nuclear Research,
Siberian Department, USSR Academy of Sciences

[Abstract] Methods are presented for increasing the voltage in synchrotron accelerators based on a symmetrical resonator in which the frequency is tuned by means of an adjustable electromagnet. The resonator consists of two short-circuited coaxial lines running counter to one another. The outer housings are coupled together mechanically and galvanically, and the space between the center conductors provides the required capacitive coupling and also serves as the accelerating space. The electromagnet consists of two identical U-shaped magnetic conductors separated by the symmetrical resonator, which is filled with ferrite. The high frequency voltage in the resonator can be adjusted over a wide range by changing the susceptance of the ferrite of the core of the resonator. The voltage can be quadrupled by using two resonators to build a symmetrical accelerating system. Figures 4, references: 3 Russian.
[326-6900]

AMPLITUDE AND PHASE TRANSFORMATION OF LIGHT WAVE BY INTERFERENCE-TYPE
MULTILAYER DIELECTRIC COATINGS

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 58, No 5, May 85 (manuscript received 27 Dec 83) pp 1102-1105

ZHDANOVA, L.A., SEREBRYAKOV, V.A. and YASHIN, V.Ye.

[Abstract] Multilayer dielectric interference coatings on transparent substrates and operating in the transmission mode are considered for changing the phase difference between the two s,p components of obliquely incident polarized light. The feasibility of such a phase shifter is demonstrated on multilayer quarter-wavelength reflecting structures, alternately SiO_2 layers (refractive index $n_{\text{high}} = 1.92$) and ZrO_2 layers (refractive index $n_{\text{low}} = 1.45$) on glass substrates ($n = 1.5$). Calculations were made on a BESM-6 high-speed computer according to the program written by V.V. Veremey, disregarding the back surface of the glass substrate. Calculations were made for a 19-layer structure (transmission coefficient $T \approx 0.72$, with K-8 glass substrate $T \approx 0.6$) under a 56.4° incidence angle and for a 25-layer structure (transmission coefficient $T \approx 0.9$, with K-8 glass substrate $T \approx 0.85$) under a 38° incidence angle. Both structures were found to operate as polarizers at the respective given incidence angles. The amplitudes of the two s,p components became equal and their phase difference reached 90° , however, under a large incidence angle (67°) for the 19-layer structure and under a smaller incidence angle (36°) for the 25-layer structure. The theoretical results were verified experimentally, in the light of a 100 W single-mode continuous-wave Nd:YAG laser emitting at the $1.064 \mu\text{m}$ wavelength. Transformation of linear polarization into a generally elliptic one was analyzed with the aid of a Glan prism. The power of incident and transmitted radiation, also of reflected radiation, was measured with an IMO-2N instrument. The polarization became circular with the incident polarization vector inclined at 60° for the 19-layer coating and at 45° for the 25-layer coating. Figures 2; references 8: 6 Russian, 2 Western.
[309-2415]

UDC 621.373:535-535.317.1

EFFECT OF TURBULENCE ON FORMATION OF IMAGES OF LASER SOURCES

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 58, No 5, May 85 (manuscript received 17 Apr 84) pp 1133-1137

BELENKIY, M.S., SAZONOVICH, V.M. and TSVYK, R.Sh.

[Abstract] The effect of atmospheric turbulence on formation of the image of a laser source by the receiver lens is evaluated, considering that turbulence along the path reduces the coherence of the wave field as well

as increases the curvature of the median wavefront. The theoretical analysis is based on the distribution of mean image luminance in an arbitrary observation plane, assuming a fixed distance L between transmitter and receiver apertures. In reception of spatially bounded light beams the displacement of the image plane from the focal plane is found to be determined by the radius of the wavefront curvature, which depends on three parameters of the optical system (Fresnel coefficient of the transmitter aperture, ratio of the radius of wavefront curvature at center of transmitter aperture to the transmitter-receiver distance L , coherence index of the laser source) and on the turbulence intensity characterizable by the ratio $q = L/k\rho_0^2$ (k - wave number, ρ_0 - coherence radius of plane wave). The experimental study of longitudinal refocusing as a result of turbulence was made in an artificial randomly nonhomogeneous medium with laboratory equipment simulating fully developed convective turbulence. The results confirm the roles played by lesser field coherence and regular curving of the median wavefront, both caused by turbulence. An evaluation of the results reveals the quantitative dependence of the image plane displacement on the turbulence intensity along the path of light beam propagation. The authors thank A.S. Gurvich and V.L. Mironov for interest and helpful discussions. Figures 3; references 15: 14 Russian, 1 Western. [309-2415]

UDC 621.373:535

ENERGY METHOD OF ANALYSIS OF OPTICAL RESONATORS WITH STRAINED MIRRORS

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 58, No 5, May 85 (manuscript received 26 Mar 84) pp 1157-1159

BEKSIYAYEV, A.Ya. and GRIMBIATOV, V.M.

[Abstract] An optical resonator with spherical mirrors in the electromagnetic field of incident and reflected waves is treated as a conservative vibratory system. The effect of an action sufficiently slower than the vibration period is analyzed, considering that the attendant relative energy change is in this case proportional to the relative frequency shift of the resonator mode. Mechanical strains in the two mirrors forming such a resonator and under impact by oppositely traveling electromagnetic waves are taken into account in calculation of energy and momentum densities by the standard method for a prolate linear resonator, considering that the electromagnetic field is a transverse one here in the first-order paraxial approximation. Both correctness and convenience of the standard method are demonstrated on a resonator containing a lenticular medium between two spherical mirrors with variable curvatures and slopes, in which case the fundamental-mode spot retains its Gaussian form but its center shifts. The resulting expressions, whose form does not depend on the mirror deformation mode, are analogous to the Maxwell equations of thermodynamics and yield the sensitivities of resonator system parameters to perturbations of field and deformation parameters. References 8: 5 Russian, 3 Western. [309-2415]

ELASTOHYDRODYNAMIC PROBLEM FLUID FLOWING TOWARD CRACK IN POROUS MEDIUM

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian
No 5, Sep-Oct 85 (manuscript received 6 Feb 84) pp 157-166

BALUYEVA, A.V. and ZAZOVSKIY, A.F., Moscow

[Abstract] A steady-state flow of a fluid toward a single crack in a boundless porous elastic medium is analyzed, specifically a discal crack whose hydraulic permeance depends on its opening. The corresponding problem of elastohydrodynamics is formulated in two approximations, either for a laminar flow according to Boussinesq's law or for an infinite local permeance but a reduced filtration area as a result of partial or complete closure of the crack surface with formation of overlap zones; both approximations yield a nonmonotonic pressure dependence of the flow rate. The problem is formulated in accordance with the Biot theory of consolidation in a half-space, whereupon its solution is sought with the aid of the generalized Gibson representation and the Hankel transformation. The resulting system of nonlinear integral equations can be solved by the method of successive approximations. In the case of filtration with overlap zones, the problem splits into two, one in the theory of elasticity with body forces produced by pressure gradients and one in the theory of filtration. Ignoring the finiteness of the local permeance makes it possible to solve these two problems sequentially rather than only simultaneously. They are solved by the variational-difference method; discretization is followed by minimization of the applicable functional by gradient projection with automatic step selection for the ratio of total increment to its linear component. Numerical calculations have been made, assuming a unity filtration coefficient, for a horizontal crack with elliptical cross-section in the ground and a vertical crack with circular cross-section in bedrock. Figures 6; references 13: 11 Russian, 2 Western (1 in Russian translation). [36-2415]

STABILITY CHARACTERISTICS OF SUPERSONIC BOUNDARY LAYER AND THEIR RELATION TO TRANSITION POINT BETWEEN LAMINAR AND TURBULENT FLOW

Novosibirsk IZVESTIYA SIBIRSKOGO OTDELENIYA AKADEMII NAUK SSSR: SERIYA TEKHNIЧЕСКИХ НАУК in Russian No 4, Issue 1, Mar 85 (manuscript received 12 Mar 84) pp 79-86

LYSENKO, V.I., Institute of Theoretical and Applied Mechanics, Siberian Department, USSR Academy of Sciences, Novosibirsk

[Abstract] The transition point between laminar and turbulent flow in a compressible boundary layer has so far been predicted by approximate methods, but neither those based on the linear theory of stability nor the e^n -method with $n = 2.7$ are adequate for supersonic boundary layers. This deficiency can be remedied by calculations based on the system of three partial differential equations describing the flow of a compressible heat-conducting gas in a boundary layer with a pressure gradient accompanying heat transfer, in accordance with the standard program for calculating the perturbation buildup coefficients under such conditions. These coefficients are determined from the system of four equations of stability in the Dan-Lin approximation and with the Reynolds number is defined in terms of the transverse or normal scale. Results obtained for conical surfaces in water (300 K) and in water (-50°C) with thermal insulation underneath by the Schubauer-Skramstad-Smith method with e^{10} and e^9 , respectively, agree closely with experimental data, which also involve the angle between perturbation wave and main flow as well as other relevant perturbation parameters such as the wave number at supersonic velocities with the Mach number up to $M = 4$. The author thanks A.A. Maslov for assistance. Figures 6; references 13: 6 Russian, 7 Western. [263-2415]

EFFECT OF DIRECTIONAL INJECTION AND SUCTION ON CHARACTERISTICS OF LAMINAR BOUNDARY LAYER WITH NEGATIVE PRESSURE GRADIENT

Novosibirsk IZVESTIYA SIBIRSKOGO OTDELENIYA AKADEMII NAUK SSSR: SERIYA TEKHNIЧЕСКИХ НАУК in Russian No 4, Issue 1, Mar 85 (manuscript received 27 Jan 84) pp 94-98

KISELEV, M.N., MOTULEVICH, V.P. and SERGIYEVSKIY, E.D., Moscow Institute of Power Engineering

[Abstract] Steady laminar flow of an incompressible fluid along a semi-infinitely large plane surface with injection or suction through pores in that surface is analyzed, assuming constant thermophysical properties and a Reynolds number not far below critical. Upon introduction of the flow

function in Liese-Dorodnitsyn variables and the pressure gradient, the corresponding two equations of momentum and energy for a self-similar flow are solved for the appropriate velocity and temperature boundary conditions at the outer edge of the boundary layer. From the solution to this boundary-value problem it is possible to determine the two most important integral characteristics of such a boundary layer, namely the skin friction $\frac{1}{2}C_f Re^{\frac{1}{2}}$ and thermal flux $Nu_x Re_x^{-\frac{1}{2}}$ (x - longitudinal coordinate, Re - Reynolds number, Nu - Nusselt number). A solution has been obtained on a YeS-1022 computer by the numerical method of elimination with a constant integration step and with an 800-mesh grid. The results indicate a decrease of skin friction and an intensification of heat transfer with increasing tangential velocity component during injection or suction with a negative pressure gradient, because then both the hydrodynamic and thermal thicknesses of the boundary layer decrease less than does the velocity head. During injection or suction with a quasi-zero pressure gradient, however, both thicknesses of the boundary layer decrease more than does the velocity head. An increase of the tangential velocity component widens the range of negative pressure gradient, which will not significantly influence the boundary layer. Analytical formulas have been derived on the basis of the computer data for the flow function and then for the thermal flux; the formula for the latter with $1 + \operatorname{erf}$ in the denominator is accurate to within 15%. Figures 3; references 8: 2 Russian, 6 Western.
[263-2415]

UDC 537.52

NANOSECOND GENERATORS OF COLD PLASMA

Novosibirsk IZVESTIYA SIBIRSKOGO OTDELENIYA AKADEMII NAUK SSSR: SERIYA TEKHNIЧЕСКИХ НАУК in Russian No 4, Issue 1, Mar 85 (manuscript received 5 Jan 84) pp 3-8

ASINOVSKIY, E.I., KOSTYUCHENKO, S.V., MARKOVETS, V.V. and MATSENKO, A.B., Institute of High Temperatures, USSR Academy of Sciences, Moscow

[Abstract] The generation of cold plasma, a dense quasi-equilibrium one or a homogeneous one far off equilibrium, by nanosecond-terawatt electric field pulses was studied in an experiment with relativistic highly underdamped electric breakdown and ionization waves in neutral or weakly ionized gas. Cylindrical glass tubes 5-100 cm long and 0.4-10 cm in diameter with metal electrodes at the ends were filled with various gases and placed inside a coaxial radio-frequency transmission line, in the gap formed by cutting out a segment of the inner conductor. The transmission line was connected on one side to an electric discharge circuit for preionization of the gas and on the other side to a generator of 3-300 kV voltage pulses of 3-40 ns duration with a 1-5 ns rise time. High electric field intensities near the cathode cause polarization of the plasma and produce a wave front which, after an induction period, breaks away and moves toward the anode at a relativistic high velocity (10^9 - 10^{10} cm/s), leaving behind a plasma column with a high electrical conductance. The anode does not influence the propagation of such

a wave until the latter has reached it. The critical electron concentration, at which the wave front becomes a knife edge, corresponds to a Debye radius equal to the tube radius. The experiment was designed for measuring the kinetics of the anode current, equal to the difference between incident current and reflected current, of the anode voltage, and of the excess positive charge in the interelectrode space. In one experiment a tube 40 cm long and 5 cm in diameter was filled with helium, where an initial electron concentration $n_e = 1.5 \cdot 10^9 \text{ cm}^{-3}$ was then produced by a glow discharge under a pressure of 1.9 kPa. Other tubes were filled with nitrogen, $\text{N}_2 + \text{He}$ mixtures (1:9, 5:5, 9:1), air, CO_2 , SF_6 , CCl_4 , acetone, neon, argon krypton, xenon, and $\text{Ne} + 2\% \text{ Ar}$, respectively. Some common trends with quantitative differences were thus established characterizing the pressure dependence of wave velocity, wave attenuation, and anode current, the velocity dependence of wave attenuation, and the dependence of the pressure corresponding to maximum wave velocity on the ionization potential as well as on the ionization mechanism. In the case of noble gases, for instance, this critical pressure was found to increase monotonically with increasing ionization potential but in the $\text{Ne} + 2\% \text{ Ar}$ mixture this relation became nonmonotonic owing to the Penning effect. Deviations of experimental data from theoretical predictions can essentially be attributed to relativistic effects. Figures 8; references 16: 10 Russian, 6 Western (1 in Russian translation). [263-2415]

UDC 518.61:533.6.011.05

WAVE DRAG OF SOLIDS OF REVOLUTION WITH FRONTAL SEPARATION ZONE IN SUPERSONIC STREAM

Novosibirsk IZVESTIYA SIBIRSKOGO OTDELENIYA AKADEMII NAUK SSSR: SERIYA TEKHNIЧЕСКИХ НАУК in Russian No 4, Issue 1, Mar 85 (manuscript received 14 Jun 83) pp 47-51

BELOV, I.A., ISAYEV, S.A., MITIN, A.Yu. and KONOVALOV, V.N., Leningrad Institute of Mechanics

[Abstract] The wave drag of bodies of revolution with a frontal separation zone, specifically a cylinder behind a disk in a parallel configuration, can be calculated on the basis of exact Navier-Stokes or Reynolds equations which include viscosity. This requires a high-speed computer with large memory capacity. It has been, instead, calculated on the basis of difference solutions to the corresponding Euler equations applicable to turbulent flow with shock waves as well as to circulation flow between bodies. The validity of this approximate model is now established by comparing the numerical solution with experimental data, of particular interest being the still largely unexplored supersonic range with the Mach number of quiescent flow $N_{\text{Moo}} > 2$. The model equations were solved numerically by the Godunov straight-through method with stabilization of the unsteady finite-difference scheme, for a wide range of geometrical dimensions and the $N_{\text{Moo}} = 2-6$ range of the Mach number. Experiments were performed in a wind tunnel over the

N_{Mo} = 1.8-4.15 range of the Mach number and a wide range of cylinder-disk configurations, the largest model dimension being 30 mm and the Reynolds number not exceeding $1.6 \cdot 10^6$. Theoretical and experimental values of the wave drag agree rather closely, except for a small disk near the cylinder. The discrepancy in this case is attributable to inaccuracy of the mathematical model, which accounts neither for artificial diffusion and consequently blurred contact discontinuity in the velocity profile with resulting appearance of a single circulation zone nor for the hysteresis effect in flow restructurization characteristic of a body with protruding spike. Figures 3; tables 1; references 13: 11 Russian, 2 Western. [263-2415]

UDC 629.735-33.015.3:533.682

TRANSIENT AERODYNAMIC CHARACTERISTICS OF FOIL IN STREAM WITH SEPARATION FLOW NEAR WAVY WALL

Novosibirsk IZVESTIYA SIBIRSKOGO OTDELENIYA AKADEMII NAUK SSSR: SERIYA TEKHNIЧЕСK KH NAUK in Russian No 4, Issue 1, Mar 85 (manuscript received 28 Sep 83) pp 56-60

MIKHAYLOVA, L.V. and SHUMSKIY, G.M.

[Abstract] Separation flow of an ideal incompressible fluid around a thin foil with a generally curvilinear profile is considered, when the foil moves broadside horizontally at a constant velocity above a horizontal wall with wavy upper surface and remains forward tilted at a constant angle. The corresponding boundary-value problem for the velocity potential with a vortex sheet originating at the leading upper edge and trailing behind the trailing lower edge is formulated in a system of nonlinear singular integral equations for the coordinates and the intensities of vortex formations. This system is first reduced to a linear one, by successive linearizations for small time intervals, and then solved numerically after it has been reduced by the method of discrete vortices to a system of algebraic equations. The aerodynamic loads on the foil are evaluated through the Cauchy-Lagrange integral. The procedure has been applied to a foil of rectilinear profile, a plate, moving from rest at a constant horizontal velocity above a wall with a sinusoidal upper surface describable by the equation $\bar{y} = o \sin N_{Sh} \bar{x}$ ($\bar{y} = y/b$ vertical coordinate, $\bar{x} = x/b$ horizontal coordinate, b - chord width of foil, o - amplitude of surface ripple, $N_{Sh} = 2\pi b/\lambda$ - Strohal number, λ - wavelength of surface profile). The vortex formation immediately above the plate becomes aperiodic when the Strohal number is still small ($N_{Sh} = 1.047$) and then becomes altogether sparse when the Strohal number is large ($N_{Sh} = 6.28$). In the latter case the aerodynamic characteristics, particularly the lift coefficient, are determined by the shape of the surface profile underneath as long as the mean altitude of the plate above the wall surface remains much smaller than the plate width. As the altitude fluctuates while the plate moves across the surface ripple, the lift coefficient cycles with hysteresis which weakens as the Strohal number decreases. Figures 9; references 6: 5 Russian, 1 Western. [263-2415]

TEMPERATURE DEPENDENCE OF STREAM VELOCITY IN LOW-PRESSURE REACTOR

Novosibirsk IZVESTIYA SIBIRSKOGO OTDELENIYA AKADEMII NAUK SSSR: SERIYA
TEKHNICHESKIKH NAUK in Russian No 4, Issue 1, Mar 85 (manuscript received
5 Apr 83) pp 75-78

VOSKOBOYNIKOV, V.V., Novosibirsk Institute of Electrical Engineering

[Abstract] The temperature dependence of the stream velocity in a low-pressure reactor was determined experimentally, considering that any such reactor used for vapor-phase deposition or gaseous-phase epitaxial growth in semiconductor and microelectronics technologies requires a vacuum pump and a throttling check valve. The equipment included two quartz tubes as reactor vessels, one with a 10.75 cm^2 large circular cross-section and one with a 6.50 cm^2 rectangular cross-section, to be placed inside a tubular electrical-resistance furnace with temperature regulator, a tank with compressed helium and a check valve, a hermetic mechanical suction pump with hydroscope, a pressure gauge at the reactor entrance and a Pitot tube which can be inserted into the reactor. There is no standard analytical solution available for the problem of gas dynamics in the vicinity of a throttle, the presence of an isothermal reactor and connecting pipes further complicating the solution. The data were therefore processed into calibration curves for discrete temperatures over the $20\text{--}1100^\circ\text{C}$ range characterizing the pressure dependence of the volumetric flow rate over the $2\text{--}100 \text{ mm H}_2\text{O}$ range. These curves are not quite linear, especially at both low and high ends, with the volumetric flow rate not depending on the geometry of the reactor cross-section and the trend of these curves being the same for all temperatures. The volumetric flow rate as a function of the reactor pressure has been calculated on the basis of the calibration curves and found to increase with rising temperature at any pressure and to level off with rising pressure at each temperature. Figures 4; references: 2
Russian.

[263-2415]

UDC 532.529.5

HYDRODYNAMICS OF VAPOR-LIQUID STREAMS IN BINARY APPARATUS WITH FILM FLOW

Minsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ENERGETIKA in Russian No 3,
Mar 85 (manuscript received 19 May 83) pp 107-110

TOCHIGIN, A.A., doctor of technical sciences, YELIN, N.N., candidate of technical sciences, and ARSENOV, V.G., engineer, "Badge of Honor" Ivanovo Institute of Power Engineering imeni V.I. Lenin

[Abstract] Dimensional analysis and similarity laws are applied to experimental data on the hydrodynamics of vapor-liquid streams in a binary

apparatus, where film flow or annular flow can be achieved at a velocity of the mixture above the velocity of a vapor stream which would draw the entire liquid film upward. Tests were performed in a 6.7 m long horizontal glass tube having an inside diameter $d = 13$ mm, with water, diesel fuel, and solutions of M20 oil in diesel fuel. The tests were performed varying the velocity of the two-phase stream over the $v = 16-30$ m/s range, the kinematic viscosity of the liquid phase over the $\nu_l = (1-114) \cdot 10^{-6} \text{ m}^2/\text{s}$ range, the density of liquid over the $\rho_l = 820-995 \text{ kg/m}^3$ range, and the surface tension over the $\sigma = (33.7-74) \cdot 10^{-3} \text{ N/m}$ range. Three dimensionless complexes were tried for generalization of the data:

$$K = \text{Re}_l \text{We}_l^{0.5}, V = (\text{Re}_l \text{Fr} \frac{\rho_2}{\rho_1 - \rho_2})^{1/3}, W = \text{Fr}^{0.5} \text{We}_l^{-0.25} (\frac{\rho_2}{\rho_1})^{0.5} \quad (\text{Re} - \text{Reynolds}$$

number, Fr - Froude number, We - Weber number, ρ_2 - density of vapor). The results of a test series with $W = \text{const} = 4.3-8.1$ indicate that this complex does not generalize readings of the kinematic viscosity and thus the intrinsic volume concentration ϕ_l of liquid. The results of series of tests within $V = \text{const} = 34.9-70.2$ and with $K = \text{const} = 1275-5990$ indicate that these two complexes do generalize readings of the intrinsic volume concentration ϕ_l at discharge volume concentrations of $\phi_l > 0.002$ and $\phi_l < 0.002$, respectively. On this basis are derived empirical formulas for the intrinsic volume concentration ϕ_l and the hydraulic drag coefficient ψ as functions of ϕ_l , also for the pressure drop Δp as a function of liquid-phase and vapor-phase parameters which are useful for the engineering design of such apparatus. The article was presented by Department of TEPP Thermal Engineering. Figures 3; references 5: 4 Russian, 1 Western (in Russian translation). [276-2415]

UDC 532.556

CHANGE IN HEAT TRANSFER INTENSITY BEHIND BEND OF STREAM IN CHANNELS

Minsk IZV"STIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ENERGETIKA in Russian No 3, Mar 85 (manuscript received 24 Sep 83) pp 112-115

VASILYEV, F.V., engineer, LIFSHITS, M.N., candidate of technical sciences, docent, and BUGLAYEV, O.V., student, "Badge of Honor" Bryansk Institute of Transportation Machinery

[Abstract] The heat transfer behind a bend of the stream, specifically a 90° elbow between two straight pipe segments with a significantly varying velocity profile, is analyzed by contrasting local singularities in such bends with the steady velocity profiles of laminar or turbulent flow in coils. Intensification of the heat transfer therefore follows different patterns in the two cases. The correction factor for intensification of heat transfer behind an elbow is defined similarly as the ratio $e_b = \text{Nu}_b / \text{Nu}_{00}$ of the Nusselt number behind a bend to the Nusselt number in a straight pipe without bend, but is calculated as a function of the ratio l/d of pipe (straight) length to pipe diameter behind the bend for a given ratio R/d of bend radius to pipe diameter. Experimental data for determining this correction factor were obtained for short pipes ($l/d < 40$) and small elbows

($R/d = 1.2$), with the Reynolds number behind the bend $N_R = 10^5$, after it has been established that the flow stabilizes hydrodynamically within a distance not exceeding $10d$ after bending. The results in this case yielded an intensification of heat transfer which decreases from 85% ($e_b = 1.85$) in an $l/d = 8$ long straight segment asymptotically to zero ($e_b = 1.0$) in an $l/d = 35$ long segment behind the bend, assuming a 25% ($e_b = 1.25$) intensification within the initial zone immediately behind the bend in accordance with the Mikheyev formula $e_1 = 1 + 2d/l$. The empirical formula $e_b = 4.45(l/d)^{-0.43}$ based on these data and accurate within $\pm 15\%$ agrees closely with the Boelter-Young-Iversen formula (1948), except that it yields a shorter segment where $e_b > 1$. The article was presented by Department of Turbine Construction. Figures 3; references 4: 3 Russian, 1 Western.
[276-2415]

UDC 536.24

RADIATIVE AND CONVECTIVE HEAT TRANSFER TO FLUIDS IN PIPES

Minsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ENERGETIKA in Russian No 3, Mar 85 (manuscript received 13 Dec 83) pp 110-112

DUNIN, I.L., candidate of technical sciences, docent, IVANOV, V.V., doctor of technical sciences, professor, and SAVENKO, V.V., engineer, Rostov Institute of Construction Engineering

[Abstract] The heating of a fluid inside a circular pipe during a stabilized steady Poiseuille flow and with the pipe heated from the outside by a combination of radiative and convective heat transfer is considered, assuming negligible axial heat conduction and energy dissipation in the stream. The applicable mathematical model, including the equation of energy in cylindrical coordinates, is put in dimensionless form with the corresponding boundary conditions stipulated in terms Peclet, Stark, and Biot numbers. On the basis of an analytical solution a relation obtained for the local Nusselt number at any point along the pipe as function of the parameter $\beta = \frac{k}{k_w} \log \frac{d_o}{d_i}$ (d_o, d_i - outer and inner diameters of pipe, k - thermal conductivity of fluid, k_w - thermal conductivity of pipe wall material). Numerical solution of the problem has been programmed for a BESM-6 high-speed computer. Results are presented for $N_{Sk} = 1$, $N_{Bi} = 1$, and the ratio of pipe inlet temperature to ambient (heating) medium temperature of $\theta_0 = T_1/T_a = \frac{1}{5}$. The article was presented by Department of Heat and Gas Supply. Figures 3; references: 2 Russian.
[276-2415]

EFFECT OF STREAM TURBULENCE ON CHARACTERISTICS OF TURBINE STAGE

Minsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ENERGETIKA in Russian No 3, Mar 85 (manuscript received 29 May 84) pp 88-96

TOPUNOV, A.M., doctor of technical sciences, professor, TIKHOMIROV, B.A., candidate of technical sciences, docent, KONYUKOV, V.L., candidate of technical sciences, and TSURIKOV, A.N., engineer "Order of Lenin" Leningrad Institute of Shipbuilding

[Abstract] Experimental data on losses due to secondary flow in turbine stages are analyzed, for the purpose of separating the effect of turbulence in the entering stream from the effect of vorticity in the initial zone and considering that the two effects are interdependent inasmuch as turbulence tends to suppress vorticity. Tests were performed with several nozzle arrays, with secondary flow and attendant losses being particularly significant in stages with relatively long blades on account of channel conicity and in stages with relatively short blades on account of the high specific friction at the tips. The data are evaluated so as to identify the profiles of flow parameters and the frequency spectrum of energy in the zone of secondary flow as well as their dependence on the turbulence; the latter is defined in terms of mean eddy viscosity in accordance with momentum conservation. On this basis are established not only the dependence of the displacement thickness on the turbulence but also the dependence of both on the tilt angle of the nozzle periphery to the incoming stream. The results indicate that, as the turbulence increases, the velocity fluctuations in the zone of secondary flow first increase and then decrease after having reached their maximum upon a relatively small 5-7% increase of turbulence, while the peak of their energy spectrum remains in the low-frequency range. The conclusions regarding the efficiency of a turbine stage are that the latter decreases with increasing turbulence in the incoming stream regardless of the displacement thickness at the stage inlet and that the decrease of eddy losses does not compensate for the increase of friction. The effectiveness of partitioning the nozzle channels for suppression of secondary flow increases with increasing displacement thickness but decreases with increasing turbulence and, since changes in the displacement thickness produce changes in the turbulence, there is a compounding effect here. The article was presented by Department of Ship Turbines and Turbine Plants. Figures 4; tables 3; references: 5 Russian. [276-2415]

STUDY OF HYDRODYNAMICS AND HEAT EXCHANGE OF LAMINAR FLOW IN SPIRAL HEAT EXCHANGE CHANNELS

Moscow TEPLOENERGETIKA in Russian No 3, Mar 85 pp 35-39

LIPATOV, V.Ye., Engineer, KUZNETSOV, Yu.N., Doctor of Technical Sciences and TIMOFEYEV, V.Ye., Candidate of Technical Sciences.

[Abstract] A study of heat exchange and hydraulic resistance in spiral channels with various spacings and near-rectangular transverse cross-sections was performed with ratios of transverse and longitudinal dimensions of 0.2 to 1.2 on an experimental installation with two circulating loops. Diesel oil circulated through one of the loops, distilled water through the other. Electric heaters were used to control the temperatures of both fluids in their storage tanks. Of all the spiral channels studied, the most intensive process of heat exchange and mechanical energy exchange between the walls of the channels and the flow occurred in channels distinguished by the length of the side of the channel extended along the channel radius. In all studies of spiral channels, the exchange of mechanical energy between the flow and the walls of the channels was greater than in the coils of tubes of circular cross-section with identical curvature parameters. The curvature parameter d/D_{av} does not unambiguously determine heat exchange and hydrodynamics in the spiral channels, as it does in circular coil and slotted rectangular channels. The heat exchange and hydrodynamics in the spiral channels studied depend in a complex manner on the relationship of all of the geometric parameters. The hydraulic resistance is determined primarily by the geometric parameters $(D_H - d_v)/D_{av}$ and the slope of the median line. Figures 5, references 9: 8 Russian, 1 Western. [297-6508]

UDC: 621.165-226.2.001.24

DISTRIBUTION OF TEMPERATURES AROUND PROFILES IMMERSED IN MOIST STEAM FLOW

Moscow TEPLOENERGETIKA in Russian No 3, Mar 85 pp 39-41

DEYCH, M.Ye., Doctor of Technical Sciences, KURSHAKOV, A.V., FROLOV, A.V., Candidates of Technical Sciences and MAKOVETS, V.P., Engineer, Moscow Institute of Power Engineering

[Abstract] Studies are under way at the author's Institute on the distribution of temperature in the layer near the walls of nozzle grids. The experiments have shown that the distribution of temperatures over the profiles differ significantly in superheated and moist steam. In superheated steam the temperature at all points along the back and concave surface is quite close to the stagnation temperature before the grid, since the Prandtl number for superheated steam approaches 1, so that the stagnation temperature

is practically completely reproduced in the boundary layer. In moist steam the distribution is determined by the distribution of static pressure. When the blade material does not conduct heat well, the temperature on the surface of a profile is equal to the steam saturation temperature at the static pressure at the corresponding point on the profile. Temperature pulsations at the surfaces of blades in moist steam resulting from pulsations of pressure and the film of moisture on the back of the profile lead to variable temperature stresses in the surface layer of the vane materials. In the transition zone between superheated and moist steam, the temperature fluctuations on the surfaces of the profiles are particularly great, possibly greatly increasing corrosion of the vane material. Figures 3, references 2 Russian.
[297-6508]

UDC: 536.248.2.001.24

INFLUENCE OF THERMAL INSTABILITY ON HEAT EXCHANGE IN SUPERCRITICAL REGION

Moscow TEPLOENERGETIKA in Russian No 3, Mar 85 pp 67-69

AFONIN, V.K. (Dissertant), Engineer, SMIRNOV, O.K., Candidate of Technical Sciences, Moscow Institute of Power Engineering.

[Abstract] The purpose of this work was the development of calculation recommendations for determination of the influence of instability factors on heat exchange which are convenient for use in computer programs. Heat exchange under both steady and transient conditions can be determined by the combination of local parameters of the coolant. The results of computations indicate that the unsteady heat transfer coefficient behind the moving crisis front are significantly lower than the quasi-steady values. In advance of the moving front, in contrast, there is a relative improvement of heat transfer. Secondly, the change in unsteady heat transfer coefficients is independent of the type, nature and depth of perturbations and hydrodynamic instability characteristics, being determined only by the thermal instability of the boundary layer of steam characterizing the relationship between the unsteady change in heat flux in the radial direction and convective flow in the axial direction. Figures 4, references 7 Russian.
[297-6408]

STUDY OF BOILING OF UNDERHEATED WATER ON TRANSVERSELY WASHED TUBES BY CINEMATOGRAPHY

Moscow TEPLOENERGETIKA in Russian No 3, Mar 85 pp 69-70

MALKIS, V.A., Dissertant, Engineer, and LOKSHIN, V.A., Doctor of Technical Sciences.

[Abstract] Results are presented from cinematography of boiling of underheated water in a model of an economizer. The model consists of a single horizontal row of tubes 0.015 m in diameter with a spacing of 0.032 m between tubes, effective length 0.02 m. Frames are shown to illustrate the boiling of the water. The vapor phase does not fully condense in the interval between tubes where the separation between them is 0.008 m or less. Where the separation between tubes is 0.008 m or more, each subsequent tube is exposed to a single-phase flow. Figure 1.

[297-6508]

UDC 532.529

PULSATIONS OF VAPOR-GAS BUBBLES IN ACOUSTIC FIELD

Baku DOKLADY AKADEMII NAUK AZERBAYDZHANSKOY SSR in Russian Vol 41, No 1, Jan 85 (manuscript received 16 Feb 82) pp 14-19

NAGIYEV, F.B. and MAMEDOVA, F.M., Institute of Mathematics and Mechanics, AzSSR Academy of Sciences

[Abstract] Small free and forced pulsations of bubbles containing vapor of a liquid and a gas dissolvable in that liquid are analyzed, taking into account the thermal effects in the acoustic field. The corresponding equations of heat flow, of continuity, of state for both phases, and of gas diffusion through the liquid are formulated in Euler coordinates. The equations of phase transition kinetics and the equation of bubble pulsations are formulated with the appropriate boundary conditions, taking into account accommodation and surface tension. The problem is solved for a single bubble with variable gas concentration in an acoustic field, after linearization and change to dimensionless quantities, so as to satisfy the condition of finite temperature and concentration at the center as well. The solution yields the amplitude and the phase of bubble pulsations under the given conditions. Numerical results have been obtained for a bubble with an average radius of 210 μm , containing a mixture of water vapor and air, and pulsating at a frequency of 20 kHz. With the Lewis number on the order of unity, corresponding to approximately equal thicknesses of both diffusional and thermal boundary layers inside the bubble (their thickness being different inside the bubble and outside the bubble in the liquid), an increase of the vapor content in a bubble of this large size results in wider fluctuations of the gas concentration in the bubble but hardly

changes the gas concentration in the ambient liquid. The article was presented by Academician (AzSSR Academy of Sciences) F.G. Maksudov. Figures 3; references: 3 Russian.
[304-2415]

UDC 536.248.2

CALCULATION OF CRITICAL THERMAL FLUX IN BOILING **WITH ITS** DEPENDENCE ON MATERIAL AND THICKNESS OF HEATER PLATE TAKEN INTO ACCOUNT

Minsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ENERGETIKA in Russian No 6, Jun 85 (manuscript received 14 Sep 84) pp 86-90

GAYDAROV, Sh.A., candidate of technical sciences, Dagestan State University

[Abstract] Calculation of the critical thermal flux in boiling, heretofore based solely on the hydrodynamic theory of critical boiling, is extended so as to take into account its experimentally established dependence on both the material and the thickness of the heater plate. The resulting thermohydrodynamic model of bubble boiling accordingly includes penetration of thermal perturbation waves from the fluid into the solid, where they set up a temperature field. Theoretical calculations are based on the bubble kinetics and on relevant thermophysical properties of heater-plate substrate and coating materials, which largely determine the depth of thermal wave penetration, with the relative thicknesses of substrate and coating as well as their relation to the penetration depth playing an important role in determining the critical thermal flux. A comparison with experimental data on nitrogen boiling at heater plates with substrate and coating made of the same metal yields a better correlation for heater plate made of stainless steel than for one made of copper, the discrepancies being attributable to unaccounted for factors such as surface finish. Article was presented by Department of Theoretical Physics. Figures 3; references 6: 4 Russian, 2 Western (1 in Russian translation).
[307-2415]

UDC: 532.516

VISCOUS FLUID FLOW NEAR LINE OF INTERSECTION OF CURVED SURFACES

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA in Russian No 3, May-Jun 85 (manuscript received 24 Nov 83) pp 16-21

GUREVICH, Yu.G., Moscow

[Abstract] A study is made of the flow of a viscous fluid with Reynolds number much greater than 1 near the line of intersection of arbitrary smooth surfaces with external mass forces. Analysis of the Navier-Stokes

equations and the energy equation as Reynolds number approaches infinity is used to obtain sufficient conditions for development of intensive transverse flow near the line of intersection, leading to a qualitative change in the flow picture. Depending on external forces and geometric parameters of the surfaces, various types of flow are possible. Equations are derived determining the development of a given type of flow, and equations and necessary boundary conditions are determined describing some of the flow types.

Figures 2, references 9: 6 Russian, 3 Western.

[328-6508]

UDC: 533.6.011.5

HYPERSONIC FLOW AROUND A WING AT LARGE ANGLES OF ATTACK WITH DETACHED COMPRESSION JUMP

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA in Russian No 3, May-Jun 85 (manuscript received 19 Mar 84) pp 149-157

GOLUBKIN, V.N. and NEGODA, V.V., Moscow.

[Abstract] A study is made of the flow around a thin delta wing with finite delta angle at large angles of attack. A theory presented in earlier works describes a conical flow with a compression jump attached only at the apex of the delta wing. Possible conditions of flow around the wing at large angles of attack are classified. The results indicate that the asymptotic theory of the shock layer for a wing of finite span is the most general, since it describes all three qualitatively different flow conditions: with a compression jump attached to the leading edge, attached only to the apex or completely detached. Figures 6, references 12: 8 Russian, 4 Western.

[328-6508]

UDC: 533.6.011.5

CIRCULATION FLOW AT FORWARD SURFACE OF A SPHERE IN A SUPERSONIC WAKE-TYPE STREAM

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA in Russian No 3, May-Jun 85 (manuscript received 2 Apr 84) pp 143-148

GOLOVACHEV, Yu.P. and LEONTYEVA, N.V., Leningrad

[Abstract] A study is made of an axisymmetrical steady flow around a spherical surface by a nonuniform supersonic wake-type stream with a formed head shock wave ahead of the body and a closed area of return circulation flow. The stream in the wake is modeled by a parallel axisymmetrical stream with constant pressure and axial velocity minimum and temperature maximum. It is shown that with fixed nonuniformity of the incident stream

an increase in Reynolds number and cooling of the body surface lead to formation of a secondary eddy in the vicinity of the intersection of the contour of the body with the axis of symmetry. Specifics of the change in resistance parameters and heat exchange over the forward surface of cooled and insulated spheres are studied. The possibility is discussed of numerical modeling of the flow based on the equations of Euler. Figures 5, references 9: 6 Russian, 3 Western.
[328-6508]

UDC: 533.6.011

SPECIFICS OF FLOW NEAR STAGNATION POINT WITH SUPERSONIC FLOW AROUND EXPONENTIALLY SHAPED BODIES

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA in Russian No 3, May-Jun 85 (manuscript received 18 Jan 84) pp 138-142

KARLOVSKIY, V.N. and LEVIN, V.A., Moscow

[Abstract] A study is made of flow around bodies with shapes described by exponential equations with shock waves for the case of infinite curvature at the tip and finite curvature but infinite second derivative of curvature with respect to the longitudinal coordinate. The shape of the shock wave at the bow is determined by the profile of the entire subsonic portion of the body. The results produced thus can be considered possible cases of the formation of shock waves. Figures 2, references 5: 4 Russian, 1 Western.
[328-6508]

UDC: 532.529:533.6.011.3

AXISYMMETRICAL POLYDISPERSED TWO-PHASE FLOW WITH PARTICLE BREAKUP AND COAGULATION WITH ARBITRARY DISTRIBUTION OF FRAGMENT MASSES AND SPEEDS

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA in Russian No 3, May-Jun 85 (manuscript received 14 Feb 84) p. 73-79

RYCHKOV, A.D. and SHRAYBER, A.A., Novosibirsk, Kiev.

[Abstract] Results are presented from a numerical study of the specifics of a two-dimensional polydispersed flow based on the use of a general model of fractionation of particles by collisions considering the reverse influence of particles. Particular attention is given to analyzing the influence of selection of a model of particle breakup on local and integral flow parameters. The results show that calculations using monodispersed and polydispersed models yield essentially different values of a number of local flow parameters, particularly the fractional composition of the condensate, as well as values of individual specific impulse loss components. Precise

calculations thus require the use of a polydispersed model of particle breakup due to collisions. Approximate determination of general flow characteristics can utilize the monodispersed model, reducing machine time by 30 to 40%. Figures 5, references 7: 6 Russian, 1 Western.
[328-6508]

UDC: 532.526.5.013

STABILITY OF SUBSONIC BOUNDARY LAYER UPON HEATING OF A SURFACE OF A FLAT PLATE NEAR THE LEADING EDGE

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA in Russian No 3, May-Jun 85 (manuscript received 22 May 84) pp 68-72

KAZAKOV, A.V., KOGAN, M.N. and KUPAREV, V.A., Moscow

[Abstract] A study is made of the simple case of heating of a gas in a boundary layer by elevating the temperature of a surface near the leading edge. It is proven that the point of loss of stability and the point of transition of the laminar boundary layer to a turbulent layer are shifted downstream. Increasing the surface temperature near the leading edge of a plate leads to an increase in stability of the flow relative to two-dimensional disturbances, an increase in critical Reynolds numbers for loss of stability and displacement of the point at which the laminar flow becomes turbulent downstream in comparison to the case of constant surface temperature. At subsonic Mach numbers, two-dimensional disturbances are decisive and flow stability calculations with respect to three-dimensional disturbances should not change the qualitative picture of the influence of nonuniform temperature distribution over the surface on flow stability characteristics in the boundary layer or the position of the transition point. Figures 4, references 10: 4 Russian, 6 Western.
[328-6508]

UDC: 532.517.4

SEMIEMPIRICAL THEORY OF TURBULENCE OF HETEROGENEOUS FLOWS WITH BODY FORCES

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA in Russian No 3, May-Jun 85 (manuscript received 9 Apr 84) pp 33-40

IYEVLEV, V.M. and SON, E. Ye., Moscow

[Abstract] A closed system of equations is obtained for the second moments defining the turbulence of transfer in heterogeneous flows with body forces in the approximation of local turbulence equilibrium. The work represents a further development of the semiempirical theory of turbulence of Rotta for heterogeneous flows in which body forces create anisotropy of turbulent

pulsations. Diffusion and convective transfer are considered. A single-scale model is studied in which the scale in the boundary layer refers to transverse scale. The equations obtained can be used for turbulent flows with moderate anisotropy. Problems with strong anisotropy require consideration of the difference between longitudinal and transverse turbulence scales. References 10: 8 Russian, 2 Western.
[328-6508]

UDC: 533.6.011.6

FLOW OF MELT FILM WITH FINELY DISPERSED IMPURITIES

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKhanika ZHIDKOSTI I GAZA in Russian No 3, May-Jun 85 (manuscript received 31 May 84) pp 158-165

LUNEV, V.V., Moscow

[Abstract] A simple method is suggested for description of the process of surface accumulation of particles and consideration of its influence on the rate of material loss. A differential equation is obtained to compute the effective evaporation surface on the assumption that the dimensions of suspended particles are small in comparison to the thickness of the film of melted carrier fluid. An example of melting of quartz with one type of impurity at the stagnation point of a blunt body is studied. The effect of surface accumulation of particles is found to be disproportionately great: even impurities of a few percent of micron-size particles may significantly increase the rate of loss of such materials, the increase being greater, the smaller the particle diameter. Figures 5, references 6 Russian.
[328-6508]

UDC 532.529

EFFECT OF DISPERSED COMPONENT ON JET TURBULENCE STRUCTURE

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 283, No 2, Jul 85 (manuscript received 6 Jun 84) pp 336-338

GAVIN, L.B. and NAUMOV, V.A., Kaliningrad Technical Institute of Fish Industry and Economy

[Abstract] The effect of a dispersed component on jet turbulence is analyzed on the basis of a system of equations for fluctuation energy k and energy dissipation ϵ , both the "mixing length" theory and experiments having already revealed an attenuation of turbulence by such a component. The eight equations in averaged variables, for a discharged axisymmetric turbulent jet of a gaseous suspension, take into account sliding of phases and rotation of particles as well as interphase interaction with attendant drag and

Magnus force. The direct effect of particles on the turbulence characteristics is represented by additional terms in the equations of two-phase flow. This system of equations was solved numerically for the appropriate boundary conditions. The results indicate that an increase of the initial particle injection rate tends to decrease the turbulence energy owing to additional dissipation and to increase it owing to higher axial velocity of the gas as a consequence of a larger transverse velocity gradient. More turbulence energy is generated than dissipated, the maximum difference varying non-monotonically along the jet axis. While the maximum difference within the initial jet segment is larger in a one-phase jet, within the main jet segment it is larger in a two-phase jet. Near the orifice, therefore, the turbulence energy is smaller in a two-phase jet. The dispersed phase thus protracts the initial jet segment, which agrees with earlier findings. Article was presented by Academician L.I. Sedov on 4 May 1984. Figures 3; references 6: 5 Russian, 1 Western.
[330-2415]

UDC 532.526.5

INCREASED STABILITY OF SUBSONIC BOUNDARY LAYER DURING HEATING OF SURFACE NEAR LEADING EDGE OF BODY IMMERSED IN STREAM

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 283, No 2, Jul 85 (manuscript received 12 Jun 84) pp 333-335

KAZAKOV, A.V., KOGAN, M.N. and KUPAREV, V.A.

[Abstract] The effect of surface heating on the stability of a boundary layer is analyzed for a flat plate in a subsonic stream with a high characteristic Reynolds number, the effect of surface cooling having already been found to increase the stability of a laminar boundary layer and to raise the critical values of the Reynolds number. The linear system of equations of perturbed flow is formulated in the plane-parallel approximation, assuming that the parameters of the main stream in the linearized corresponding Navier-Stokes equations are functions of only the coordinate across the boundary layer. The problem of such a two-dimensional flow reduces to an eigenvalue problem for a system of ordinary differential equations whose solution depends on the real longitudinal wave number and the complex wave frequency of perturbations. The problem is solved after transformation to a system of finite-difference equations. The region of unstable perturbation buildup and the integral perturbation gain in space as function of the perturbation frequency in time are determined on this basis, also the boundary of neutral stability. Then the effect of heating the plate surface not far from its leading edge, with a linear longitudinal temperature gradient, is found to extend the boundary of neutral stability toward higher critical values of the Reynolds number and to narrow the range of unstable frequencies, while also decreasing the perturbation buildup in space at fixed values of the frequency parameter $F = \omega \mu_{00} / \rho_{00} u_{00}^2$ (μ_{00} , ρ_{00} - dynamic viscosity and density of the gas,

u_{∞} - velocity of the quiescent stream, ω - frequency of perturbations). Calculations for a quiescent stream with a Mach number $N_M = 0.1$ reveal such an effect even with a not optimum temperature distribution, namely an appreciably weaker buildup of Tolmin-Schlichting waves in space and a downstream shift of the transition point. Article was presented by Academician A.A. Dorodnitsyn on 12 June 1984. Figures 2; references 5: 1 Russian, 4 Western.
[3300-2415]

UDC 537.312.62

DEVICE FOR PRODUCING HIGH PRESSURES AT TEMPERATURES DOWN TO 0.1 K

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 281, No 5, Apr 85
(manuscript received 27 Jun 84) pp 1094-1097

ALEKSEYEVSKIY, N.Ye., corresponding member, USSR Academy of Sciences, NAROZHNYI, V.N., DODOKIN, A.P. and BAGDASAROV, Kh.S., Institute of Problems in Physics and Institute of Crystallography imeni A.V. Shubnikov, USSR Academy of Sciences, Moscow

[Abstract] A device for producing pressures up to 20 kbar at temperatures down to 0.1 K has been built, an improvement over diamond anvils with an ice "bomb" for pressurizing up to 2 kbar and adiabatic demagnetization of a paramagnetic salt in a solution cryostat for cooling below 1 K. It utilizes the high mechanical strength of YAG single crystals ($\text{Er}_x\text{Y}_{3-x}\text{Al}_5\text{O}_{12}$, $x \approx 1.5$), two such crystals being formed into cylindrical anvils facing each other with their conical tips separated by a pyrophyllite washer holding a specimen of the test substance. The two anvils, inside a cylindrical yoke made of beryllium bronze, are pressed together between two cone springs. This high-pressure device is placed inside the vacuum compartment of a Dewar flask made of glass and containing helium-4. After isothermal magnetization and subsequent removal of the coolant by a carbon sorption pump, adiabatic demagnetization is effected in the same manner as in the case of paramagnetic salt. An advantage of YAG crystals is that they obey Curie's law down to temperatures below 0.1 K. The device was calibrated on a specimen of pure cadmium, with a set of Helmholtz coils for compensation of terrestrial magnetism and with axial slots in the bronze yoke suppressing eddy currents. Cadmium is characterized by a resistance ratio $RRR = 4000$ and a linear pressure dependence of the superconducting transition temperature with a negative slope $dT_c/dP = -18 \cdot 10^{-6}$ K/bar. Pressures up to 20 kbar were obtained with forces up to 100 kgf, with a negligible widening of the superconducting transition range. The device was then used for study of the superconductor material NdMo_6S_8 ($T_c = 3.4$ K, maximum compressibility $2 \cdot 10^{-6}$ bar $^{-1}$) under pressure, the results revealing an anomalously large negative pressure coefficient $dT_c/dP = -1.6 \cdot 10^{-4}$ K/bar. The authors thank L.N. Bulayevskiy for constructive discussion. Figures 4; references 15: 6 Russian, 9 Western.
[256-2415]

APPROXIMATE METHOD OF SOLVING PROBLEMS OF HEAT CONDUCTION FOR HOLLOW CYLINDER

Dushanbe IZVESTIYA AKADEMII NAUK TADZHIKSKOY SSR: OTDELENIYE FIZIKO-MATEMATICHESKIKH, KHIMICHESKIKH I GEOLOGICHESKIKH NAUK in Russian No 1, Jan-Mar 84 (manuscript received 19 Jan 83) pp 73-76

YUSUPOV, S.Yu., Tadzhik Polytechnical Institute

[Abstract] An approximate method avoiding unwieldy calculations is proposed for solving problems of transient heat conduction with mixed boundary conditions of third and fourth kinds. The method, which combines integral transformations and orthogonal projections, is applied to a specific boundary-value problem for a hollow cylinder and its temperature field T

$$\frac{\partial T}{\partial N_{Fo}} = \frac{1}{m+1} \frac{\partial}{\partial \xi} \left[(m+1) \frac{\partial T}{\partial \xi} \right] + \frac{q_v(\xi, N_{Fo}) R^2}{\lambda}$$

$$T(\xi, N_{Fo})_{N_{Fo}=0} = T_0$$

$$\left[\frac{\partial T}{\partial \xi} - N_{Bi} T(\xi, N_{Fo}) \right]_{\xi=0} = -N_{Bi} \phi_c(N_{Fo})$$

$$\left(\frac{\partial T}{\partial \xi} \right)_{\xi=1} = \frac{R}{\lambda} \phi(N_{Fo})$$

where $N_{Fo} = \alpha t / R^2$ is the Fourier number and $N_{Bi} = \alpha R / \lambda$ is the Biot number, $m = (R - R_1) / R_1$, $\xi = (r - R_1) / (R_0 - R_1)$, and r is the radial coordinate (R_0 - outside radius, R_1 - inside radius, t - time, α - thermal diffusivity, λ - thermal conductivity, α - heat transfer coefficient, q_v - thermal flux, ϕ - thermodynamic potential). After a Laplace integral transformation, the approximate solution to this equation is sought as a vector drawn over coordinate functions in a finite-dimensional Hilbert space. Its coefficients are found by inverse transformation and reduction to algebraic form. The accuracy of such an approximate solution is determined by the convergence of approximate eigenvalues to the exact ones, and can be estimated over given ranges of the arguments ξ , N_{Fo} , m , N_{Bi} . Tables 1; references: 3 Russian. [285-2415]

HYDRODYNAMIC CRITERION FOR MAGNETIC ANTISCALING ACTIVATION OF PLANT WATER

Kiev ENERGETIKA I ELEKTRIFIKATSIYA in Russian No 1, Jan-Mar 85 pp 42-44

KOCHMARSKIY, V.Z., candidate of physico-mathematical sciences, KRIVTSOV, V.V., engineer, and KOBYLINSKIY, S.P., engineer, Ukrainian Institute of Water Economy

[Abstract] Water activation by means of a magnetic field is widely used in industrial power systems, especially for preventing scale formation in heat exchangers and cooling equipment. For the purpose of design and performance analysis, particularly for determining the optimum velocity of water flowing through the magnetic action zone, an experimental study was made under conditions typical of a power or heating plant. Water with a 6.0-6.5 mg·equ/dm³ hardness level and a pH= 7.5 was magnetically activated while flowing through tubes with inside diameters d= 3, 4, 9, 20, 48 mm. A magnetic field of 100 kA/m intensity was applied across a 90 mm long activation zone, also magnetic fields of 20-50-150 kA/m intensity were applied across the 20 mm tube. Water, after passing through the activation zone, was driven into a multisegmental flowthrough heat exchanger under a heat load of 3.6 kW/m² on a reference tube. As the hydrodynamic criterion for evaluating the efficiency of magnetic activation has been selected the parameter

$\lambda = 207d \frac{\log(Re/(7 + \alpha))}{Re^{7/4}}$ ($\alpha = 0$ for smooth tube surface, $\alpha = \frac{k}{d} Re$ for rough tube surface, k - relative linear roughness, d - tube diameter). This parameter obeys closely the three-halves power laws $\lambda = d(35/Re)^{3/2}$ for a smooth tube surface and $\lambda = d(31/Re)^{3/2}$ for a rough tube surface with $k = 0.1k_e$ ($k_e = 0.1$ mm equivalent mean roughness). The efficiency of magnetic antiscaling activation is found to peak softly up to 50%, depending on the tube diameter and the magnetic field intensity, at a water velocity within the $v = 0.5-2$ m/s range or within the $Re = (3.5-14) \cdot 10^4$ range of the Reynolds number. With respect to the parameter λ , the efficiency normalized to the efficiency at $\lambda = 0$ peaks steeply within the $\lambda = 2-4$ range and to decrease softly beyond that range. On the basis of these conclusions, design nomograms have been constructed for selection of optimum tube diameters depending on the water velocity v and the Reynolds number. Figures 3; references: 3 Russian. [286-2415]

UNIVERSAL CRYOSTAT FOR LIQUID HELIUM

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 2, Mar-Apr 85
(manuscript received 27 Feb 84) p 239

BONDARENKO, V.I., DINABURG, L.B., SEMENOV, S.V. and FOKEYEV, V.F.

[Abstract] A cryostat for testing various specimens in liquid helium is described. The system consists of a stainless steel tank in an outer housing that makes it possible to change tanks to accommodate the size and configuration of the object being tested. The cryostat can be configured with a gas unit to measure the consumption of evaporating helium vapors. The system weighs 680 kg. Figures 1.

[326-6900]

UDC 681.78

RTPG-1004 4.2-150 K PROGRAMMABLE TEMPERATURE REGULATOR

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 2, Mar-Apr 85
(manuscript received 28 Mar 84) pp 239-240

ZOLOTNITSKIY, V. Ya. and IVANOV, V.G.

[Abstract] This article describes the RTPG-1004 temperature regulator, which provides the capability of adjusting temperatures according to a computer-assigned program, of changing temperature manually in increments of 0.5 K, of stabilizing the temperature at a given point, and of displaying the assigned temperature. The device is employed for low-temperature electron paramagnetic resonance investigation of specimens, and is used in conjunction with relaxometers (radiospectrometers). The system consists of a thermostat block, a device for creating a vacuum in the measurement cell (cavity), and a Dewar vessel containing a helium tube. The regulator operates by heating liquid helium vapors to an assigned temperature in the vicinity of the specimen (in the cavity). The temperature in the vicinity of the investigated specimen can be set to within ± 0.5 K, and specimen temperature stability ± 0.2 K over 30 minutes is provided. The temperature can change at a rate exceeding 1 K/min. Figures 1.

[326-6900]

^3He - ^4He DISSOLUTION REFRIGERATOR FOR MAGNETIC INVESTIGATIONS AT HIGH PRESSURES

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 2, Mar-Apr 85
(manuscript received 24 May 84) p 238

DYAKONOV, V.P. and FITA, I.M.

[Abstract] A ^3He - ^4He dissolution refrigerator is described for magnetic measurements in solid bodies with up to 12 kbar compression at temperatures of 4.2-0.05 K. Good heat contact is provided by placing the 100 cm³ beryllium bronze high pressure vessel directly in the dissolution chamber. No low-temperature seals are used, which makes the device simple and easy to assemble and operate. The system in question has been operated for 3.5 years, with more than 100 weekly cooling cycles. The device employs a system of measurement permitting measurements of magnetodielectrics under pressure. Figures 1, references: 1 Russian.
[326-6900]

UDC 681.527.2

INDUCTIVE PRESSURE SENSOR

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 2, Mar-Apr 85
(manuscript received 4 Oct 83) pp 220-222

SHEFTEL, B. Sh.

[Abstract] A bellows-type device for sensing pressures and pressure differences is described. The sensing element is a 28x4x0.16 beryllium bronze bellows whose movements are converted to an electrical signal by two inductance coils. The device provides a measurement range of 0.08-1.8 MPa for unilateral operation, and 0.04-0.09 MPa for bilateral operation. Three modifications of the sensor are described: A pressure sensor connected to a bridge measurement circuit contained in a separate module, two pressure sensors connected to a common electrical measuring circuit that adds the signals proportional to pressure and compensates distortions caused by inertial and gravity effects, and the pressure sensor consisting of a receiving device on which the elements of a bridge circuit are mounted. The symmetrical construction of the elements makes the sensor insensitive to the effects of high pressures when measuring small pressure differences. Figures 3, references: 2 Russian.
[326-6900]

VALVE FOR AGGRESSIVE GASES

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 2, Mar-Apr 85
(manuscript received 27 Mar 84) p 219

PETROV, S.V., Institute of Physical Problems, USSR Academy of Sciences

[Abstract] A monel-metal needle valve employed as a cock on a copper tank containing liquid hydrogen fluoride is described. The needle seat, seal, and inserts are made of polytetrafluorethylene. The threading that moves the needle is protected against the gaseous hydrogen fluoride and against corrosion products by placing it above a PTFE seal. Ten years of experience using these valves has shown them to be reliable and usable with aggressive and dust-laden gas over a wide range of temperatures (-100 – $+200^{\circ}\text{C}$) and pressures (0.1 – 10^7 Pa). Figures 1.
[326-6900]

UDC 621.646.2-2.982

HIGH-VACUUM AND SUPERHIGH-VACUUM FLAT PENDULUM-TYPE LOCKS

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 2, Mar-Apr 85
(manuscript received 14 Feb 84) pp 214-215

ARININ, L.V., DANILOV, K.D., KOLLEROV, E.P., KAZAKOV, V.I., KURBATOV, O.K., L'VOV, B.G., and SHNITKO, M.V.

[Abstract] A flat high-vacuum lock with conventional bore of 160 mm is described. The lock consists of a welded stainless steel housing provided with flanges for coupling to the high vacuum system and flanges for coupling to the preliminary evacuation system. The housing encloses a butterfly valve that is moved by a universal-joint system. The system provides an operating life exceeding 10^5 cycles with flows through the valve of less than $5 \cdot 10^{-11}$ 1·Torr·sec $^{-1}$. High vacuum locks with bores of 100, 160, 250, and 400 mm, have been developed, as have superhigh vacuum locks with bores of 100, 160, and 250 mm. The system does not require high precision manufacture, and can open and close in less than 5 seconds. Figure 2, references: 5 Russian.
[326-6900]

AMPLIFICATION OF SHOCK WAVES IN AQUEOUS SUSPENSION OF CLAY PARTICLES

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 286, No 1, Jan 86
(manuscript received 20 Nov 84) pp 70-73

NIGMATULIN, R.I. and PYZH, V.A., Institute of Mechanics, Moscow State University imeni M.V. Lomonosov

[Abstract] Experiments with shock waves in an aqueous suspension of kaolinite were performed to study the anomalous pressure "amplification" at a wave front propagating through such a heterogeneous medium. Kaolinite particles of the 10^{-6} m size fraction were used for this purpose, on account of their low kinetic stability with a sedimentation velocity of the order of 10^{-6} m/s even at concentrations as high as several percent. The tests were performed in a shock tube with a diaphragm separating the two-phase medium from the high-pressure compartment prior to being punctured. Each test involved a sequence of 10 impacts by a gas "piston" with 2.4 MPa pressure on the column of dispersed material under a 0.1 MPa initial pressure. Oscillograms of the pressure buildup kinetics reveal an excess-pressure peak whose duration and average magnitude increase monotonically during successive impact sequences but eventually "saturate". In suspensions with 20-30% kaolinite, the velocity of the incident and reflected waves remained constant and approximately equal to the velocity of sound in pure water (1450 m/s) throughout the test; reflections by walls were acoustic. In a suspension with only 10-15% montmorillonite already, meanwhile, propagation of shock waves had been found to decelerate nonlinearly under impact pressures to as low as 2-3 MPa already; their reflections by rigid walls were nonacoustic. The article was presented by Academician G.G. Chernyy on 20 November 1984. Figures 3; references 3: all Russian. [79-2415]

ACOUSTOELECTRIC TRANSDUCER FOR DISPLACEMENT MEASUREMENT

Moscow METROLOGIYA in Russian No 11, Nov 84 pp 16-21

ZHOVNIR, N.F.

[Abstract] An acoustoelectric transducer is considered for measuring small displacements with high sensitivity and high accuracy over a wide dynamic range. Such a device, which operates with traveling surface acoustic waves, consists of a piezoelectric sound guide between a stationary interdigital coupling exciter connected to an electric oscillator on the input side and a movable metallized dielectric coupling plate on the output side. The sound guide carries two matching loads, and its active surface remains parallel to that dielectric plate at an adjustable fixed distance h while the plate slides. The performance of this device is calculated according to a model of discrete sources for the interdigital structure. The theoretical dependence of both the amplitude and the phase of the output signal on the relative air-gap width h/λ referred to the wavelength and on the relative displacement x of the coupling plate along the sound guide is correlated with experimental data. Measurements were made on a transducer with a Y-cut LiNbO_3 crystal ($d_x = 10.0$ mm, $d_y = 1.0$ mm, $d_z = 60$ mm) as a sound guide, with an interdigital structure containing 19 pairs of 20 μm wide bars deposited on that crystal, with an aperture of 2.5 mm, and with an 80 μm space period of metallization on the movable coupling plate. Surface acoustic waves propagating at a velocity of 3488 m/s were guided in the Z-direction, and an electric signal of a frequency of 43.73 MHz was applied from a G4-143 oscillator. The phase difference was measured with a resolving power of 0.2° over the -180 -($+180$) $^\circ$ range. The results indicate that $h/\lambda = 0.15$ - 0.5 is the optimum range of air-gap setting for a sufficiently stable output signal with a phase which is not sensitive to variations of that air gap. This transducer has a sensitivity of $4.5^\circ/\mu\text{m}$, a resolving power of 0.05 μm , and an accuracy within ± 0.5 μm . Figures 3; references 3: 1 Russian, 2 Western (1 in Russian translation). [300-2415]

FORCED AXISYMMETRIC VIBRATIONS OF REGULARLY STRATIFIED BODY CONSISTING OF ALTERNATING SPHERICAL LAYERS

Kiev PRIKLADNAYA MEKhanika in Russian Vol 21, No 3, Mar 85 (manuscript received 30 Mar 84) pp 3-7

SHULGA, N.A. and VISHTAK, A.P., Institute of Mechanics, UkSSR Academy of Sciences, Kiev

[Abstract] A body is considered which consists of alternating two isotropic spherical layers, each layer having a different thickness and its material having a different density as well as different values of the Lamé constants. The mechanical properties of this body are assumed to be piecewise-constant periodic functions of the radial coordinate. The problem of axisymmetric deformation under a periodic load is formulated in a spherical system of coordinates, with the displacement and stress components replaced by two scalar potentials. These scalar potentials, one of longitudinal expansion-compression waves, one of transverse shear waves, satisfy corresponding wave equations beyond the spherical surfaces at which the mechanical properties pass through discontinuities. The boundary conditions are stipulated for displacements and stresses at boundaries between layers, assuming a rigid contact, and for stresses only at the cavity surface. The solution to the wave equations is sought in Legendre polynomials with spherical Bessel functions of first and second kinds in the coefficients. The problem is then reduced to an infinite systems of algebraic equations which, to find the bounded solution only, can be split into two mutually independent subsystems for the constant coefficients of Bessel functions in the expansion-compression potentials and for the constant coefficients of Bessel functions in the shear potentials, respectively. The problem was solved in a numerical experiment for a semiinfinitely large body consisting of spherical layers with a ratio of cavity radius to shell thickness of $r_0/h = 100$ and a thickness ratio of different layers of $h_1/h_2 = 7/3$, with their materials having densities of $\rho_1/\rho_2 = 2$, Poisson's ratios of $\nu_1 = 0.3$ and $\nu_2 = 0.35$, and Young's moduli of $E_1/E_2 = 20$. Calculations were made with the normalized dimensionless frequency first 0.628 in the pass band for all waves and then 6.28 in the stop band for all waves. Figures 1; references: 6 Russian. [267-2415]

STABILITY OF TORISPHERICAL AND TORICONICAL CONTAINER BOTTOMS UNDER INTERNAL PRESSURE

Kiev PRIKLADNAYA MEKhanika in Russian Vol 21, No 3, Mar 85 (manuscript received 20 Sep 83) pp 40-45

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[Abstract] Cylindrical containers with torispherical or toriconical bottoms are considered for ultrahigh-pressure vessels and high-pressure vessels, respectively; such shapes represent the optimum tradeoff between totally tensile membrane stresses and most practical design. The stability of such vessels under internal pressure has been analyzed according to the shell theory in curvilinear systems of coordinates, with a computer program implementing the method of finite differences on curvilinear grids. Circumferential membrane stresses in the cylindrical part as well as in the narrow toroidal transition part and in the bottom part were calculated for containers made of a material with a Young's modulus of $E = 67.9$ GPa. In containers with torispherical bottoms under a pressure of 414 kPa, the ratio of sphere radius to cylinder diameter was typically 1.18 and in containers with toriconical bottoms under a pressure of 100 kPa the vertex angle was varied from 60° to 180° (flat bottom). In both kinds of containers the ratio of cylinder height to cylinder diameter was 0.20 or 0.31, the ratio of cylinder diameter to bottom thickness was varied over the 500-2000 range, and the ratio of toroidal transition radius to cylinder diameter was varied over the 0.05-0.40 range. The membrane stresses were found to become compressive in the middle of the toroidal transition and, as such, to govern the load capacity of the vessels. The critical load can and has been calculated on this basis, for performance and design analysis, as function of the various geometrical variables. Figures 4; references 12: 5 Russian, 7 Western.

[267-2415]

UDC 533.6.013.42

NONLINEAR PARAMETRIC VIBRATIONS OF CYLINDRICAL SHELLS FILLED WITH LIQUID AND INITIALLY DEFLECTED

Kiev PRIKLADNAYA MEKhanika in Russian Vol 21, No 3, Mar 85 (manuscript received 30 Mar 84) pp 46-56

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[Abstract] Nonlinear parametric vibrations of a cylindrical shell containing a liquid and having an initial deflection are analyzed with a refinement, namely taking into account the existence of nonlinearly

coupled flexural modes. The calculations are made for a closed cylindrical shell on hinge supports, only partly filled with a nonviscous incompressible fluid and under axial compression by a force which varies cosinusoidally in time. The initial deflection of this shell is assumed to have the general form $w_0 = (f_{10} \cos sy + f_{20} \sin sy) \sin \alpha x + f_{30} \sin^2 \alpha x$, and the radial displacements of the shell as well as its initial shape distortions are assumed to be much smaller than its radius of curvature. The corresponding system of equations describing this shell-liquid system according to the nonlinear theory of shallow shells is formulated so as to include structural damping, with impermeable shell walls and with a velocity potential of the liquid satisfying the Laplace equation. Application of the Bubnov-Galerkin variational method to this system of equations, after the hydrodynamic pressure has been calculated from the Lagrange-Cauchy integral, reduces it to a system of nonlinear differential equations of motion for a cylindrical shell with liquid under an axial load. This system is now analyzed for parametric resonance vibrations, in the specific case where $f_{20} = 0$ ($f_{10} \neq 0$, $f_{30} \neq 0$), for steady-state modes corresponding to four groups of stationary solutions, and for stability of the latter. Figures 4; references 12: 9 Russian, 3 Western. [267-2415]

UDC 621.357.7

PRODUCIBILITY OF THIN NICKEL-BASE NONMAGNETIC ANTIFRICTIONAL COATINGS

Vilnius TRUDY AKADEMII NAUK LITOVSKOY SSR, SERIYA B: KHIMIYA, TEKHNIKA, FIZICHESKAYA GEOGRAFIYA in Russian No 1, Jan-Feb 85 (manuscript received 24 Nov 83) pp 16-22

RACINSKIFENĖ, S.S. and RAMANAUSKIENĖ, D.K., Institute of Chemistry and Chemical Technology, LSSR Academy of Sciences

[Abstract] A feasibility study was made on coating a surface directly from the electrolyte with lustrous self-lubricating composite film of submicron thickness as antifrictional layer. Such coatings, nonmagnetic and of high purity, were produced with nickel from Limed NB-1 electrolyte, after the optimum hypophosphite concentration had been determined experimentally. The electrolyte was stirred by a stream of compressed air, with its pH being maintained within the 2.5-3.5 range and its temperature held at 40-45°C. Polydispersed micropowders with particle sizes ranging from 0.1 to 3 μm were added in the process, and their quantity was measured by weighing on a platinum substrate before and after dissolution in dilute HCl. The quality of coating films was examined visually and under a Neophot-2 optical microscope with 200-500x magnification, after grinding from 40 μm thickness down and etching with a solution containing 18 ml HNO_3 concentrate + 64 ml ethyl alcohol. A stable suspension of the strongly hydrophobic MoS_2 powder could be obtained with the aid of a surfactant, but the powder concentrated at the coating surface and made it rough, with microcracks appearing underneath. The strongly hydrophobic PFTE (polytetrafluoroethylene) distributed evenly in nickel coatings, but in clusters and very few of them in coatings up to 1 μm

thick. These coatings remained lustrous and did not crack. Only in coatings thicker than 2 μm did the concentration of PTFE powder reach 17 vol.%. The best results were obtained with graphite powder, a strongly hydrophilic substance, forming filiform inclusions in concentrations up to 12 vol.%. These coatings were without cracks, but the luster gradually diminished with a coating thickness exceeding 3 μm . A high uniform distribution of graphite powder is attainable with a high degree of powder hydrophilization. On the basis of these results, only finely-dispersed graphite will yield nickel-base nonmagnetic antifrictional coatings. Figures 5; references 9: 5 Russian, 4 Western.
[257-2415]

UDC 533.601.342:534.13

IDENTIFICATION OF ULTRAHARMONIC SELF-EXCITED VIBRATIONS DURING AERODYNAMIC INTERFERENCE IN TANDEM ARRAY OF CIRCULAR CYLINDERS IN SKEWED STREAM

Kiev DOKLADY AKADEMII NAUK UKRAINSKOY SSR, SERIYA A: FIZIKO-MATEMATICHESKIYE I TEKHNICHESKIYE NAUKI in Russian No 4, Apr 85 (manuscript received 19 Mar 84) pp 27-30

KAZAKEVICH, M.I., GRAFSKIY, I.Yu. and REDKO, S.F., State Planning Institute 'Dneprproyektstal konstruktsiya' (Dnepr Project Steel Design), USSR Central State Construction Office

[Abstract] An experimental study was made in a wind tunnel, for the purpose of establishing the mechanism of aeroelastic vibrations of two circular cylinders in a tandem array with aerodynamic interference in the air stream. The model cylinders were 400 mm long and either 75 mm or 100 mm in diameter both, each with end washers made of sized, ground, enamel-coated triple-layer papermaché. The cylinders were placed transversely in an air stream one behind the other, not in line but at a skew relative to the stream and with partial overlap. The first (upstream) cylinder was rigidly mounted, to allow a rigorous evaluation of its effect on the flow around the second (downstream) cylinder as well as on the attendant aerodynamic forces and the aeroelastic response of that second cylinder. Measurements at a stream velocity of 20-25 m/s with a Reynolds number of $N_R = 1.07 \cdot 10^5$ yielded the drag coefficient and the shear force coefficient at the front surface of the second cylinder, both as functions of the two principal spacing coordinates: center-to-center distances x and y in the directions along the stream and across the stream, respectively, with both coordinates nondimensionalized by being referred to the cylinder diameter d . An analysis of the oscillograms and evaluation of data in terms of the Strouhal number reveal interference of nonsteady aerodynamic forces acting on both cylinders and simultaneously interacting with one another. They indicate that the aeroelastic vibrations of the second cylinder are self-excited biharmonic ones, with the ultraharmonic component at twice the natural frequency dominating the harmonic component at natural frequency of the cylinder (natural frequency corresponding to zero stream velocity). Interaction of the stream and the second cylinder, resulting in

transverse vibrations of the latter, can be approximately described by a nonlinear second-order differential equation in the transverse coordinate y with unknown coefficients characterizing the nonsteady aerodynamic forces and with a biharmonic function of time on the right-hand side. This equation can be solved after those coefficients have been determined numerically from experimental data. The data obtained in this experiment spacing of the two cylinders over the $\bar{x} = x/d = 0-2.0$ and $\bar{y} = y/d = 0-1.75$ ranges. The article was presented by Academician (UkSSR Academy of Sciences) N.G. Bondarev. Figures 3; tables 1; references: 3 Russian. [291-2415]

UDC 621.039.531

RADIATIVE EROSION OF WELDED JOINTS CONNECTING STRUCTURAL STEELS CONSIDERED FOR THERMONUCLEAR REACTOR PLANTS

Moscow ATOMNAYA ENERGIYA in Russian Vol 58, No 2, Feb 85 (manuscript received 1 Mar 84) pp 104-110

KALIN, B.A., POLSKIY, V.I., SKOROV, D.M., GONCHAROV, Ye.Ye., ARTEMENKOV, I.L. and MOROZOV, A.P.

[Abstract] An experimental study was made for the purpose of evaluating the radiative erosion of welded joints exposed to bombardment by helium ions and thermonuclear plasma clusters in fusion reactors. Under consideration were welded joints connecting parts made of stainless steels, austenitic and ferritic ones, for the first wall. Such joints were bombarded by 20 keV ions in a double-focusing mass-spectrometer and by 40 keV ions in an ILU-3 ion accelerator; in each case a $1 \cdot 10^{22} \text{ m}^{-2}$ dose heated the target to temperatures not exceeding 350 K. Bombardment by plasma clusters took place in an MK-200 plasma accelerator, with 1-3 pulses of up to 50 μs duration and a 400 kJ/m^2 mean energy density. Specimens of 0.8-1.5 mm thick strip had been welded with a refractory forward-polarity electrode in an argon atmosphere at a rate of 4-5 mm/s, whereupon 10 mm long and 10 mm wide areas including half the seam and the adjacent zone on one side were irradiated in spots not larger than 5 mm in diameter. The specimens were then examined by the method of tracking autoradiography and under an EMV-100L electron microscope. The microstructure in the welding pool was found to be cellular in the case of the two austenitic steels 12Cr18Ni10Ti and EI-847, dendritic in the case of the two ferritic steels Cr13Mo2S2 and Cr13Mo2Yu2, and mixed in the case of the ferritic steel Cr13Mo2SiYul+ 1.5% TiO₂. The microhardness and the erosion rate, the latter in terms of atoms per ion, were measured across the width of specimens at various distances from center line of the weld. The results reveal identical but intricate profiles in the case of the austenitic steels, with erosion increasing with strength and depending on the state of stress where residual stresses of the second kind play the key role. In the case of ferritic steels, maximum erosion occurs within the welding pool, with the peak shifting somewhat away from the weld and, unlike in the case of welded TsMo-6 molybdenum alloy, with a second peak occurring within the zone of

low-temperature temper and hot working by welding action. Figures 5; tables 3; references 13: 11 Russian, 2 Western. [287-2415]

UDC 677.11.024.324.226

PRACTICAL APPLICATION OF 'GROUNDING EFFECT'

Dushanbe IZVESTIYA AKADEMII NAUK TADZHIKSKOY SSR: OTDELENIYE FIZIKO-MATEMATICHESKIKH, KHIMICHESKIKH I GEOLOGICHESKIKH NAUK in Russian No 1, Jan-Mar 84 (manuscript received 14 Jan 83) pp 28-34

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[Abstract] The "grounding effect" during ablative breakdown of a metal layer by combined action of a shock-compressed plasma and a laser beam was discovered by the author in 1973. The gist of this effect is that the ablation rate depends largely on whether the metal target is electrically isolated from ground and thus neutral or connected either directly to ground to to a much larger mass of metal. In the latter case the shock-compressed plasma is softer and the ablation rate is lower. Numerous practical applications of this effect in metal treatment and forming as well as in metal behavior control have already been explored and demonstrated. One particular specialized application is hardening of metal parts such as thread guides and thread drums for textile machines. The problem of feasibility is tackled by analysis of mechanical strength requirements and adaptation of shock-compressed plasma and laser beam characteristics to these requirements. An experimental feasibility study was made with equipment consisting of a capacitor bank charged through a high-voltage rectifier and discharging through a pair of electrodes into a dielectric discharge chamber, plasma flowing out of this chamber through an orifice and a nozzle onto the metal part. The metal part rests on a dielectric base, two switches connecting it to or disconnecting it from the ground and a large metal mass respectively, its surface also being irradiated by a laser beam passing through the plasma stream. The strength of the metal part was measured with a PMT-ZU4.2 hardness tester before and after treatment. Although parts made of 20A steel were of particular interest in this application for the textile industry, parts made of other alloys (brass, duralumin) and pure metals (iron, copper) were also tested. The results indicate that the strength of parts is indeed appreciably increased and their life correspondingly lengthened by this treatment, much more with than without grounding. An additional advantage of this treatment is that it smoothens rough surfaces and cures surface defects. The equipment, including three IMZ-100 pulse capacitors with a 3 kV - 100 μ F rating, does not cost more than 500 rubles and occupies less than 3 m² of floor area, draws only 1.0-1.5 kW from the power line, and can be handled by one operator or can be automated. This compares very favorably with a plasmatron for surface coating, which costs 137,000 rubles, occupies 140 m² of floor area, draws 45 kW from the power line, and requires three operators. The author thanks P.M. Solozhenkin for active

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